Measurement Studio™ Measurement Computing™ Edition

User Manual

March 2006
374318A-01

MEASUREMENT COMPUTING™

Worldwide Technical Support and Product Information

ni.com

National Instruments Corporate Headquarters

11500 North Mopac Expressway Austin, Texas 78759-3504 USA Tel: 512 683 0100

Worldwide Offices

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Contents

About This Manual

The *Measurement Studio Measurement Computing Edition User Manual* introduces the concepts associated with the Measurement Studio class libraries and development tools. This manual assumes that you have a general working knowledge of Microsoft Visual Studio, including .NET Windows and ASP.NET.

How To Use this Manual

Measurement Studio 8.0.1 includes one CD with support for both Visual Studio .NET 2003 and Visual Studio 2005. This manual documents the Measurement Studio for Visual Studio 2003/2005 CD. The Measurement Studio support for Visual Studio .NET 2003 and Visual Studio 2005 CD includes separate, parallel sets of class libraries, integration features, and support documentation for developing with Visual Studio .NET 2003 and Visual Studio 2005.

The *Measurement Studio Measurement Computing Edition User Manual* is organized into four chapters. Chapter 1, *Introduction to Measurement Studio Measurement Computing Edition*, is an overview of Measurement Studio Measurement Computing Edition. This chapter includes installation and deployment requirements, installation instructions, and a list of Measurement Studio resources. Chapter 2, *Measurement Studio Measurement Computing Edition .NET Class Libraries*, includes information about the .NET class libraries. Chapter 3, *Measurement Studio Integrated Tools and Features*, includes information on using Measurement Studio Measurement Computing Edition tools and features integrated into the Visual Studio environment. Chapter 4, *Getting Started with Measurement Studio*, includes walkthroughs that guide you through step-by-step instructions on how to develop with Measurement Studio features.

Use this manual as a starting point to learn about Measurement Studio. Refer to the *NI Measurement Studio Help* within the Visual Studio environment for function reference and detailed information about the Measurement Studio class libraries, wizards, assistants, and other features.

Conventions

The following conventions appear in this manual:

<> — Text enclosed in angle brackets represents directory names and parts of paths that may vary on different computers, such as <Windows\System>.

» — The » symbol leads you through nested menu items and dialog box options to a final action. The sequence **File»Page Setup»Options** directs you to pull down the **File** menu, select the **Page Setup** item, and select **Options** from the last dialog box.

 — This icon denotes a tip, which alerts you to advisory information.

 — This icon denotes a note, which alerts you to important information.

bold — Bold text denotes items that you must select or click on in the software, such as menu items and dialog box options. Bold text also denotes class library member names or emphasis.

italic — Italic text denotes parameters, variables, cross-references, or an introduction to a key concept. Italic text also denotes text that is a placeholder for a word or value that you must supply.

`monospace` — Text in this font denotes text or characters that you enter from the keyboard, sections of code, programming examples, and syntax examples. This font also is used for the proper names of disk drives, paths, directories, programs, device names, filenames and extensions, and code excerpts.

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Introduction to Measurement Studio Measurement Computing Edition

Measurement Studio Measurement Computing Edition is an integrated suite of tools and class libraries that are designed for developers using .NET Windows and ASP.NET to develop measurement and automation applications.

Measurement Studio Measurement Computing Edition dramatically reduces application development time through object-oriented measurement hardware interfaces, advanced analysis libraries, scientific user interface controls for Windows and Web applications, wizards, interactive code designers, and highly extensible .NET classes. You can use Measurement Studio Measurement Computing Edition to develop a complete measurement and automation application that includes data acquisition, analysis, and presentation functionalities.

The Measurement Studio Measurement Computing Edition package includes two CDs—one with Measurement Studio 8.0.1 and the other with Measurement Computing device drivers. This manual documents the Measurement Studio Measurement Computing Edition CD, which includes separate, parallel sets of Measurement Studio class libraries and support documentation for developing with Visual Studio .NET 2003 and Visual Studio 2005.

Installation Requirements

To install Measurement Studio, your computer must have the following:

- Microsoft Windows 2000/XP
- Microsoft .NET Framework 1.1 for Visual Studio .NET 2003 or Microsoft .NET Framework 2.0 for Visual Studio 2005
- Standard, Professional, Enterprise Developer, Enterprise Architect, or Academic edition of Microsoft Visual Studio .NET 2003 and Microsoft Visual Studio 2005 (required to use the Measurement Studio

integrated tools) or Visual C#, Visual Basic, or Visual C++ Express Editions of Microsoft Visual Studio 2005

Measurement Studio integration tools are not supported in the Visual Studio 2005 Express Editions.

- Intel Pentium II class processor, 733 MHz or higher
- Video display—800 × 600, 256 colors (16-bit color recommended for user interface controls)
- Minimum of 256 MB of RAM (512 MB or higher recommended)
- Minimum of 405 MB of free hard disk space for Visual Studio .NET 2003 support and minimum of 385 MB of free hard disk space for Visual Studio 2005 support
- Microsoft-compatible mouse
- Microsoft Internet Explorer 6.0 or later

Optional Installation—In order for links from Measurement Studio help topics to .NET Framework help topics to work, you must install the Microsoft .NET Framework SDK 1.1 for Visual Studio .NET 2003 or Microsoft .NET Framework SDK 2.0 for Visual Studio 2005.

Deployment Requirements

To deploy an application built with Measurement Studio .NET class libraries, the target computer must have a Windows 2000/XP operating system and the .NET Framework version 1.1 for Visual Studio .NET 2003 or the .NET Framework version 2.0 for Visual Studio 2005.

Installing Measurement Studio

Complete the following steps to install Measurement Studio. These steps describe a typical installation. Please carefully review all additional licensing and warning dialog boxes.

Note There are separate installers for Measurement Studio support for Visual Studio .NET 2003 and Measurement Studio support for Visual Studio 2005. Repeat the installation instructions to install support for both.

1. Insert the Measurement Studio CD into the CD drive. `autorun.exe` automatically starts. If it does not automatically start, double-click the `autorun.exe` icon.

2. Click **Install NI Measurement Studio for Visual Studio .NET 2003** or click **Install NI Measurement Studio for Visual Studio 2005**.
3. Click **Next** to install all NI software to the default installation directory, or click **Browse** to select a different installation directory. You must install Measurement Studio to a local drive. Click **Next**.

Note The option to browse for an installation location is valid only if you have not already installed any Measurement Studio features. If you have any Measurement Studio features installed, then Measurement Studio installs to the same root directory to which you installed other Measurement Studio features.

4. From the feature tree, select the features you want to install. To change the Measurement Studio installation directory, select the first feature in the list and click **Browse**. Click **Next**.
5. Review the license agreement and select **I accept the License Agreement(s)**. Click **Next**.
6. In the Installation Summary dialog box, review the features you selected. Click **Next**.

Note Step 8 starts the installation of Measurement Studio. Be aware that when the installer indicates that it is removing backup files, this is a normal operation. The installer may take several minutes to complete this step.

7. If prompted, insert the Device Drivers CD and select **Rescan Drive**. If not prompted, go to step 13 on this list.
8. From the feature tree, select the Device Drivers components you want to install. To change a driver installation directory, select the driver and click **Browse**. Click **Next**.
9. In the Product Information dialog box, carefully review important information about the features you are installing. Click **Next**.
10. If there is a license agreement associated with the driver software, review the license agreement and select **I accept the License Agreement(s)**. Click **Next**.
11. In the Installation Summary dialog box, review the features you selected. Click **Next**.
12. Click **Next** to complete the installation.
13. If prompted, click the appropriate restart option. If you did not install a component that requires a restart, you will not be prompted to restart.

Measurement Studio Features

The following list contains features included in Measurement Studio. Refer to `mccdaq.com/mstudio` for more information about the features and functionality included in Measurement Studio.

- Windows Forms user interface controls
- Web Forms user interface controls
- Analysis class library
- Universal Library class library
- MccDaq Scan Components class library
- GPIB class library

Measurement Studio Resources

As you work with Measurement Studio, you might need to consult other resources. For detailed Measurement Studio help, including function reference and in-depth documentation on developing with Measurement Studio, refer to the *NI Measurement Studio Help* within the Visual Studio environment. The *NI Measurement Studio Help* is fully integrated with the Visual Studio help. You must have Visual Studio installed to view the online help, and you must have the Microsoft .NET Framework SDK 1.1 for Visual Studio .NET 2003 or the Microsoft .NET Framework SDK 2.0 for Visual Studio 2005 installed in order for links from Measurement Studio help topics to .NET Framework help topics to work. You can launch the *NI Measurement Studio Help* in the following ways:

- From the Windows Start menu, select **Start»All Programs» National Instruments»<Measurement Studio>»Measurement Studio Documentation**. The help launches in a stand-alone help viewer.
- From Visual Studio, select **Help»Contents** to view the Visual Studio table of contents. The *NI Measurement Studio Help* is listed in the table of contents.
- From Visual Studio, select **Measurement Studio»NI Measurement Studio Help**. The help launches within the application.

Tip As you work through this manual, you will see italicized references to relevant help topics. To find these topics, use the table of contents in the *NI Measurement Studio Help*.

The following resources also are available to provide you with information about Measurement Studio.

- Examples—Measurement Studio installs examples to the following paths:
  - Visual Basic .NET or Visual C#—`Program Files\National Instruments\<MeasurementStudio>\DotNET\Examples`
- Measurement Computing Technical Support—Refer to Appendix A, *Contacting Measurement Computing Corp.*, for more information.
- Measurement Studio Measurement Computing Edition Web site, `mccdaq.com/mstudio`—Contains Measurement Studio news, support, and downloads.
- NI Developer Zone, `zone.ni.com`—Provides access to online example programs, tutorials, technical news, and a Discussion Forum where you can participate in Measurement Studio discussion forums for Visual Basic 6.0, Visual C++, and .NET languages.

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Measurement Studio Measurement Computing Edition .NET Class Libraries

This chapter provides overview information about the .NET class libraries included with Measurement Studio Measurement Computing Edition support for Visual Studio .NET 2003 and Visual Studio 2005. Refer to the *Using the Measurement Studio .NET Class Libraries* section of the *NI Measurement Studio Help* for detailed information about these libraries. Refer to Chapter 4, *Getting Started with Measurement Studio*, for step-by-step instructions on developing applications with these libraries.

Measurement Studio Support for Visual Studio .NET 2003 Class Library Overview

- *Analysis*
- *Common*
- *MCC-488.2*
- *Universal Library*
- *MccDaq Scan Components*
- *User Interface*

Refer to the following sections for information about each Measurement Studio .NET class library.

Analysis

The Measurement Studio Analysis .NET class library is in the `NationalInstruments.Analysis` namespace. The Analysis class library includes a set of classes that provides various digital signal processing, signal filtering, signal generation, peak detection, and other general mathematical functionality. Use this library to analyze acquired data or to generate data.

The Analysis class library includes the following functionality:

- Sawtooth, sine, square, triangle, and basic function wave generators.
- Bessel, Chebyshev, Inverse Chebyshev, Windowed, Kaiser, and Elliptic Low, High, Bandpass, and Bandstop filters
- Signal processing functions such as convolution, deconvolution, correlation, decimation, integration, and differentiation
- FFT, Inverse FFT, Real FFT, Fast Hartley, Inverse Fast Hartley, Fast Hilbert, Inverse Fast Hilbert, DST, Inverse DST, DCT, and Inverse DCT transformations
- Linear algebra functions such as determinant, check positive definiteness, calculate dot product, and other various matrix functions
- Scaled and unscaled windowing classes
- Common statistical functions such as mean, median, mode, and variance
- Exponential, linear, and polynomial curve fitting functions
- Signal generation functions

Refer to the following lists to determine the type of measurements available in the Analysis .NET libraries.

Measurements

- Impulse Response Function
- Network Functions (avg)

Signal Generation

- Arbitrary Wave
- Chirp Pattern
- Gaussian White Noise
- Sine Pattern

- Sine Wave
- Square Wave
- Triangle Wave
- Uniform White Noise

Windowing

- Blackman Window
- Blackman-Harris Window
- Blackman-Nuttall Window
- Cosine Tapered window
- Dolph-Chebyshev Window
- Exact Blackman Window
- Exponential Window
- Flat Top Window
- Force Window
- Gauss Window
- General Cosine Window
- Hamming Window
- Hanning Window
- Kaiser Window
- Scaled Time Domain Windows
- Symmetric Time Domain Windows
- Triangle Window

Filters

- Bessel
- Butterworth
- Cascade
- Chebyshev
- Elliptic
- FIR
- FIR Windowed
- IIR

- IIR Cascade
- Inverse Chebyshev
- Kaiser

Signal Processing

- Autocorrelation
- Convolution
- Cross Power
- Cross Correlation
- Decimate
- Deconvolution
- Derivative x(t)
- Discrete Cosine Transform
- Discrete Sine Transform
- Fast Hartley Transform
- Fast Hilbert Transform
- Integral x(t)
- Inverse Fast Hartley Transform
- Inverse Fast Hilbert Transform
- Peak Detection
- Power Spectrum
- Pulse Parameters
- Real and Complex FFT
- Threshold Peak Detector

Linear Algebra

- Complex Determinant
- Complex Dot Product
- Complex Matrix Condition Number
- Complex Matrix Norm
- Complex Matrix Rank
- Complex Outer Product
- Complex Pseudo Inverse Matrix

- Determinant
- Dot Product
- Inverse Matrix
- Matrix Condition Number
- Matrix Multiplication
- Matrix Norm
- Matrix Rank
- Outer Product
- Pseudo Inverse Matrix
- Special Matrix
- Test Positive Definite Matrix
- Trace
- Transpose

Array and Numeric Operations

- 1D and 2D Array Arithmetic
- 1D and 2D Linear Evaluation
- Evaluation
- 1D Polar to Rectangular
- 1D Rectangular to Polar
- Complex Number Arithmetic
- Find Polynomial Roots
- Scale 1D and 2D

Curve Fitting

- Exponential Fit
- General Least Squares Linear Fit
- General Polynomial Fit
- Linear Fit
- Nonlinear Fit

Statistics

- Histogram
- Mean
- Median and Mode
- Moment about Mean

Tip For more information about analyzing or generating data with the Analysis class library, refer to the *Using the Measurement Studio Analysis .NET Library* topic in the *NI Measurement Studio Help*. For more information about the functionality included in the Analysis class library, visit `ni.com/analysis` and select **Analysis in Measurement Studio**.

Common

The Measurement Studio Common .NET class library is in the `NationalInstruments` namespace. The Common class library provides a set of classes that facilitates the exchange of data between the acquisition, analysis, and user interface portions of your application. The Common class library includes the following features:

- A `ComplexDouble` data type. This data type represents a complex number of type `Double` that is composed of a real part and an imaginary part.
- A `DigitalWaveform` data type. This data type represents a set of digital states that are grouped by samples or signals.
- An `AnalogWaveform` data type. This data type represents an analog signal that varies over time.
- A `DataConverter` class that converts data from one data type to another data type, such as converting an array of integers to an array of doubles.
- An `EngineeringFormatInfo` class that defines a custom formatter to format numeric values as strings with engineering notation and International System of Units (SI) prefixes and symbols.

Tip For more detailed information about the Common class library, refer to the *NationalInstruments* section in the *NI Measurement Studio Help*.

MCC-488.2

The Measurement Studio MCC-488.2 .NET class library is in the `MccDaq.Mcc4882` namespace. This class library is included when you install the MCC-488.2 driver. The MCC-488.2 class library includes a set of classes for communicating with GPIB instruments, controlling GPIB devices, and acquiring GPIB status information. Use this library to design code that communicates with and controls instruments on a GPIB interface. Use the MCC-488.2 class library to configure and communicate with GPIB devices using the `Device` and `Board` classes.

Universal Library

The Measurement Studio Universal Library .NET class library is in the `MccDaq` namespace. This class library is included when you install the Universal Library driver. Use the Universal Library class library to communicate with and control Measurement Computing data acquisition (DAQ) devices.

Use the Universal Library class library to perform the following types of tasks:

- Analog signal measurement
- Analog signal generation
- Digital I/O
- Counting and timing
- Temperature measurement

MccDaq Scan Components

The Measurement Studio Scan Components .NET class library is in the `MccDaq.ScanComponents` namespace. The MccDaq Scan Components library includes a set of components for reading and writing multiple channels of analog data.

Use the MccDaq Scan Components library to perform the following types of tasks:

- Analog input scans
- Analog output scans

User Interface

The Measurement Studio user interface controls are in the Windows Forms and Web Forms .NET class libraries. Refer to Table 2-1 for the UI controls provided by Measurement Studio.

Table 2-1. Measurement Studio User Interface Controls

User Interface Controls	Visual Studio 2005		Visual Studio .NET 2003
	Windows Forms	Web Forms	Windows Forms
Waveform graph	✔	✔	✔
Scatter graph	✔	✔	✔
Digital waveform graph	✔	✔	✔
Complex graph	✔	✔	✔
Legend	✔	✔	✔
Knob	✔	✔	✔
Gauge	✔	✔	✔
Meter	✔	✔	✔
Slide	✔	✔	✔
Thermometer	✔	✔	✔
Tank	✔	✔	✔
Numeric edit	✔	✔	✔
Switch	✔	✔	✔
LED	✔	✔	✔
Property editor	✔		✔
Array controls	✔		
AutoRefresh control		✔	

Windows Forms Controls

The Measurement Studio user interface controls are in the Windows Forms .NET class library. The Windows Forms .NET class library is in the `NationalInstruments.UI.WindowsForms` namespace. The Windows Forms class library encapsulates the following Measurement Studio user interface controls:

- Waveform graph
- Scatter graph
- Digital waveform graph
- Complex graph
- Legend
- Knob
- Gauge
- Meter
- Slide
- Thermometer
- Tank
- Numeric edit
- Switch
- LED
- Property editor

Use this class library to add measurement-specific user interface controls to your application. You can configure the controls programmatically at design time, through the Properties window in the Windows Forms Designer, or at run time with the property editor control. The following sections describe each of the Measurement Studio Windows Forms user interface controls.

Tip For more information about easily using the .NET user interface controls, refer to the *Using the Measurement Studio Windows Forms .NET Controls* section in the *NI Measurement Studio Help*.

Waveform Graph and Scatter Graph Controls

Use the Measurement Studio waveform graph and scatter graph controls, as shown in Figure 2-1, to display two-dimensional data on a Windows Forms user interface. Use the waveform graph to display two-dimensional linear data. You explicitly specify each value in one dimension and provide an initial value and interval to implicitly specify the values in the other dimension. Use the scatter graph to display two-dimensional linear or nonlinear data. You explicitly specify each value in both dimensions.

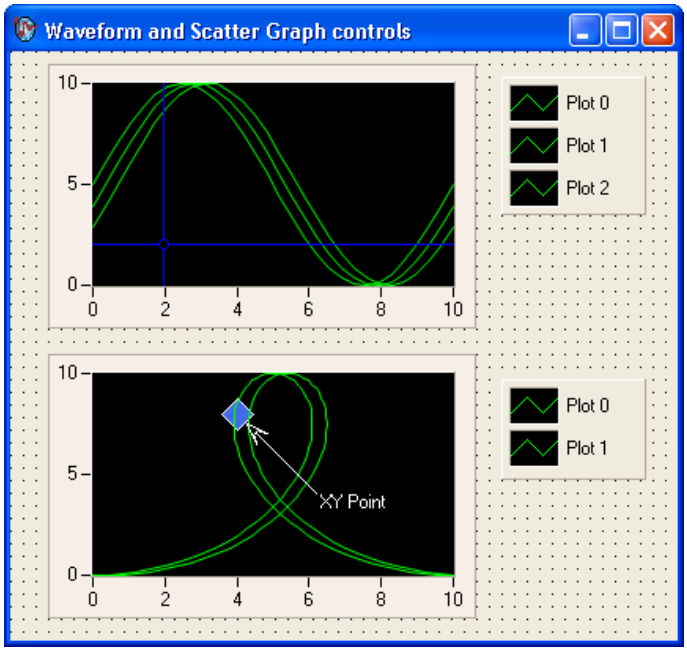


Figure 2-1. Windows Forms Waveform Graph Control with Cursors and Windows Forms Scatter Graph Control with XY Point Annotation; Both Graphs Have Corresponding Legends

With the waveform graph and scatter graph controls and the classes that interface with the controls, you can perform the following operations:

Plot Operations

- Plot and chart data.
- Configure a graph to contain multiple plots to show separate but related data on the same graph.
- Draw lines or fills from a plot to an X value, Y value, or another plot.

- Specify plots in the scatter graph control as X and Y data. Specify plots in the waveform graph control as X or Y data and optionally with date and time scaling.
- Use the extensible plot and plot area drawing capabilities and events to customize the graph appearance.
- Use plot data tooltips to display X and Y coordinates when a user hovers the mouse over a data point.
- Create custom point and line styles for plots.
- Specify anti-aliased plots for plot lines.

Axis Operations

- Configure a graph to include multiple axes or independent ranges so that plot data fits the graph plot area.
- Configure the axis modes to fixed, exact autoscaling, loose autoscaling, strip chart, or scope chart.
- Use logarithmic axes with configurable bases.
- Interactively change the range of an axis and invert the axis at run time by clicking on the axis end labels.

Cursor Operations

- Use cursors to identify key points in plots and the plot area.
- Configure cursor snap modes to be fixed, floating, nearest point, or to plot.
- Use cursor labels to display X and Y data coordinates that the cursor crosshair points to, and customize the text font and colors of the label.
- Create custom point and line styles for cursors.

Annotation Operations

- Configure text labels, arrows, and drawing shapes to annotate a point anywhere in the plot area of the graph.
- Configure range area, text labels, and arrows to annotate a range in the plot area of the graph.

Additional Operations

- Pan and zoom interactively.
- Configure major, minor, and custom divisions and origin lines.

- Copy the graph as a BMP, GIF, JPEG, or PNG image to the clipboard or a file.

Tip For more information about using the waveform and scatter graph controls, refer to the *Using the Measurement Studio Windows Forms Scatter and Waveform Graph .NET Controls* section in the *NI Measurement Studio Help*.

Digital Waveform Graph Control

Use the Measurement Studio digital waveform graph control, as shown in Figure 2-2, to display `DigitalWaveform` data on a Windows Forms user interface.

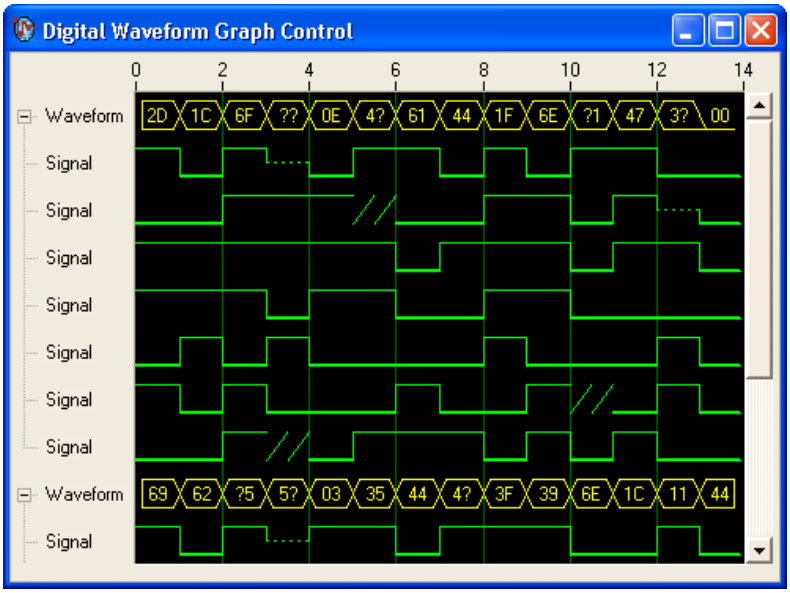


Figure 2-2. Windows Forms Digital Graph Control

With the digital waveform graph control and the classes that interface with the control, you can perform the following operations:

Plot Operations

- Plot digital waveform data. Data values can represent up to eight different digital states.
- Configure plot labels on the y-axis.
- Configure plot templates to customize plots that are implicitly created from plotted data.

- Specify anti-aliased digital plots.
- Expand and collapse signal plots interactively.

Waveform Sample and Signal State Operations

- Simultaneously display waveforms and signals or display signals only.
- Create custom waveform sample and signal state styles.
- Configure sample and state labels.
- Create custom waveform sample and signal state labels.

Axis Operations

- Configure the axis modes to fixed, exact autoscaling, or loose autoscaling.
- Interactively change the range of an axis and invert the axis at run time by clicking on the axis end labels.

Additional Operations

- Display data in sample or time mode.
- Pan with scroll bars.
- Configure the style and mode of scroll bars.
- Create custom scroll bars.
- Pan and zoom interactively.
- Configure major, minor, and custom divisions.
- Copy the graph as a BMP, GIF, JPEG, or PNG image to the clipboard or a file.

Tip For more information about using the digital waveform graph control, refer to the *Using the Measurement Studio Windows Forms Digital Waveform Graph .NET Control* section in the *NI Measurement Studio Help*.

Complex Graph Control

Use the Measurement Studio complex graph control, as shown in Figure 2-3, to display `ComplexDouble` data on a Windows Forms user interface. A `ComplexDouble` consists of a real part and an imaginary part.

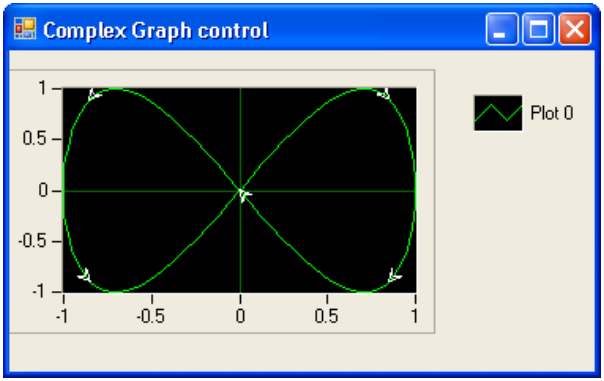


Figure 2-3. Windows Forms Complex Graph Control

With the complex graph control and the classes that interface with the control, you can perform the following operations:

Plot Operations

- Plot and chart `ComplexDouble` data.
- Configure a graph to contain multiple plots to show separate but related data on the same graph.
- Draw lines or fills from a plot to an X value, Y value, or another plot.
- Use the extensible plot and plot area drawing capabilities and events to customize the graph appearance.
- Configure the plot to display arrows. The arrows indicate the direction of the complex data.
- Create custom point and line styles for plots.
- Specify anti-aliased plots for plot lines.

Axis Operations

- Configure a graph to include multiple axes or independent ranges so that plot data fits the graph plot area.
- Configure the axis modes to fixed, exact autoscaling, loose autoscaling, strip chart, or scope chart.
- Interactively change the range of an axis and invert the axis at run time by clicking on the axis end labels.

Additional Operations

- Pan and zoom interactively.
- Configure major, minor, and custom divisions and origin lines.
- Copy the graph as a BMP, GIF, JPEG, or PNG image to the clipboard or a file.

Tip For more information about using the complex graph control, refer to the *Using the Measurement Studio Windows Forms Complex Graph .NET Control* section in the *NI Measurement Studio Help*.

Legend Control

Use the Measurement Studio legend control, as shown in Figure 2-1, to display symbols and descriptions for a specific set of elements of another object, such as the plots or cursors of a graph. When you associate the legend control with another object, any changes you make to that object are automatically reflected in the legend. For example, if you associate the legend control with the plots of a graph, any changes you make in the plots collection editor are automatically reflected in the legend.

Tip For more information about using the legend control, refer to the *Using the Measurement Studio Windows Forms Legend .NET Control* section in the *NI Measurement Studio Help*.

Numeric Controls

Use the Measurement Studio numeric controls to display numerical information, on a Windows Forms user interface, with the look of scientific instruments. The numeric controls include a knob, gauge, meter, slide, thermometer, and tank. The following sections describe operations available with the controls and the classes that interface with them.

With all of the numeric controls and the classes that interface with them, you can perform the following operations:

- Configure the scale to be linear or logarithmic and toggle the visibility of the scale.
- Fill the scale and configure the range, color, dimensions, and style of the fill.
- Connect to the Measurement Studio .NET numeric edit control so that if you change the value of one control, it changes the value of the other control.

- Customize the appearance of the control using 3D lab styles or classic 2D styles and change the color and length of ticks and labels.
- Configure the format of value labels to engineering or date/time.

Use the Measurement Studio knob, gauge, and meter controls, as shown in Figure 2-4, to input and display numeric data on your user interface.

Figure 2-4. Windows Forms Knob, Gauge, and Meter Controls

With the knob, gauge, and meter controls and the classes that interface with the controls, you can perform the following operations:

- Specify the start and sweep angle of the arc programmatically or from the Properties window.
- Use automatic division spacing, custom divisions, and invert the scale.

Use the Measurement Studio slide, tank, and thermometer controls, as shown in Figure 2-5, to input and display numeric data on your interface.

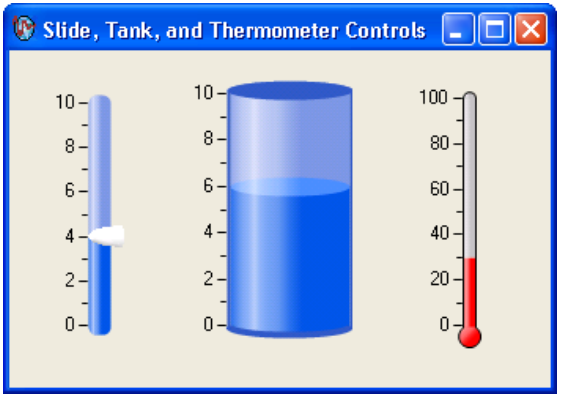


Figure 2-5. Windows Forms Slide, Tank, and Thermometer Controls

With the slide, tank, and thermometer controls and the classes that interface with them, you can perform the following operations:

- Fill to the minimum or maximum value of the scale.
- Position the scale horizontally with left, right, or both and position the scale vertically with top, bottom, or both.

Tip For more information about using the Windows Forms knob, gauge, meter, slide, tank, or thermometer controls, refer to the *Knob*, *Gauge*, *Meter*, *Slide*, *Tank*, or *Thermometer Class* sections in the *NI Measurement Studio Help*.

Numeric Edit Control

Use the Measurement Studio numeric edit control, as shown in Figure 2-6, to display numeric values and to provide a way by which end users can edit numeric values. Typically, you use a numeric edit control to input or display double numerical data instead of using a Windows Forms TextBox or NumericUpDown control.

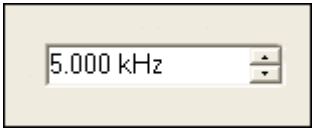


Figure 2-6. Windows Forms Numeric Edit Control

With the numeric edit control and the classes that interface with the control you can perform the following operations:

- Use up/down buttons for easy incrementing and decrementing.
- Perform range checking.
- Set the minimum range value to negative infinity and the maximum range value to positive infinity.
- Create custom formats or use built-in numeric formats including generic, engineering, and simple double.
- Connect to a Measurement Studio numeric control so that if you change the value of one control, it changes the value of the other control.
- Set the coercion mode property to discrete or continuous values. This property configures the control to allow entry or display of either a discrete set of values or any value.
- Set the interaction mode to keyboard and mouse, keyboard only, mouse only, or none.

Tip For more information about using the Windows Forms numeric edit control, refer to the *NumericEdit Class* section in the *NI Measurement Studio Help*.

Switch and LED Controls

Use the Measurement Studio switch and LED controls as Boolean controls on a Windows Forms user interface. You typically use a switch control, as shown in Figure 2-7, to receive and control Boolean input on an application user interface.

Figure 2-7. Windows Forms Switch Control in Vertical Toggle 3D Style

You typically use an LED control, as shown in Figure 2-8, to indicate a Boolean value on an application user interface.

Figure 2-8. Windows Forms LED Control in Square 3D Style

With the switch and LED controls and the classes that interface with the controls, you can perform the following operations:

- Receive notification before or after the state of the control changes.
- Configure how the control behaves when you click it with the mouse or press the spacebar when the control has focus.
- Configure the appearance of the control.
- Make the control background transparent.
- Configure the LED control to blink while it is on or off and configure the rate at which the LED control blinks.

Tip For more information about using the switch and LED controls, refer to the *Using the Measurement Studio Windows Forms Switch and LED .NET Controls* section in the *NI Measurement Studio Help*.

Property Editor Control

Use the Measurement Studio property editor control, as shown in Figure 2-9, to configure properties for Windows Forms controls at run time.

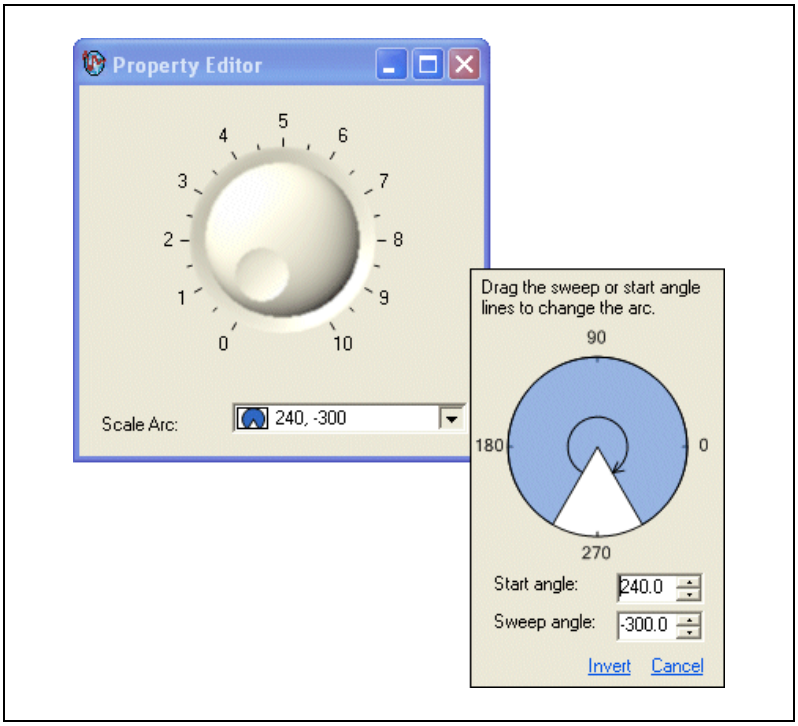


Figure 2-9. Windows Forms Property Editor Control for the Windows Forms Knob Control Scale Arc Property

With the property editor control and the classes that interface with the control, you can perform the following operations:

- Edit any .NET type at run time, including collections.
- Edit expandable properties that represent nested properties of another object, such as major divisions of an axis.
- Create custom editors and type converters for properties.
- Connect to a Windows Forms control so that if you change the value of a property of the control, the property editor will update to reflect the change.
- Configure the display mode as a visual representation of the value, text-only, or both.
- Set the interaction mode to edit values or indicator.

Tip For more information about using the property editor control, refer to the *Using the Measurement Studio Windows Forms Property Editor Control* topic in the *NI Measurement Studio Help*.

Measurement Studio Support for Visual Studio 2005 Class Library Overview

Measurement Studio support for Visual Studio 2005 includes all of the features and functionality described in the *Measurement Studio Support for Visual Studio .NET 2003 Class Library Overview* section as well as the following additional user interface features and functionality:

- Windows Forms array controls
- ASP.NET Web Forms controls

Windows Forms Array Controls

You can create an array of Measurement Studio controls that behave as a single unit. For example, you can use these array controls to visualize and control ports of a digital line or values of an array. Measurement Studio includes switch, LED, and numeric edit array controls. You can create control arrays of other controls if those controls meet the constraints of the generic type parameter `TControl`.

Switch and LED Array Controls

Use the Measurement Studio switch and LED array controls as an array of Boolean controls on a Windows Forms user interface. You typically use a switch array control, as shown in Figure 2-10, to control ports of a digital line or values of an array. You typically use an LED array control, also shown in Figure 2-10, to visualize ports of a digital line or values of an array.

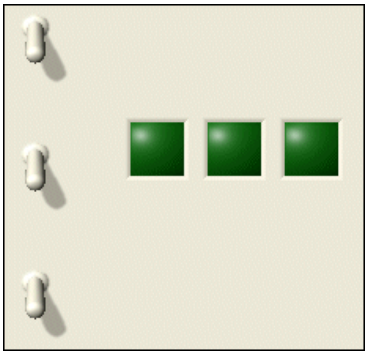


Figure 2-10. Windows Forms Switch and LED Array Controls

With the switch and LED array controls and the classes that interface with the controls, you can perform the following operations:

- Set values by passing an array of data.
- Modify the number of controls displayed based on the length of the specified values.
- Receive notification before or after the state of the control changes.
- Configure how the control behaves when you click it with the mouse or press the spacebar when the control has focus.
- Configure the appearance of the control.
- Make the control background transparent.
- Configure the LED controls to blink while they are on or off and configure the rate at which the LED controls blink.

Tip For more information about using the switch and LED array controls, refer to the *Using the Measurement Studio Windows Forms Control Array .NET Controls* topic in the *NI Measurement Studio Help*.

Numeric Edit Array Control

Use the Measurement Studio numeric edit array control, as shown in Figure 2-11, to control and visualize values of an array of `double` values.

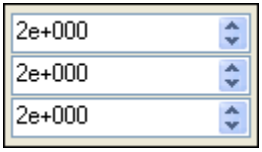


Figure 2-11. Numeric Edit Array control

With the numeric edit array control and the classes that interface with the control you can perform the following operations:

- Set values by passing an array of data.
- Modify the number of controls displayed based on the length of the array of values you specify.
- Use up/down buttons for easy incrementing and decrementing.
- Perform range checking.
- Set the minimum range value to negative infinity and the maximum range value to positive infinity.
- Create custom formats or use built-in numeric formats including generic, engineering, and simple double.
- Connect to a numeric control so that if you change the value of one control, it changes the value of the other control.
- Set the coercion mode property to discrete or continuous values. This property configures the control to allow entry or display of either a discrete set of values or any value.
- Set the interaction mode to keyboard and mouse, keyboard only, mouse only, or none.
- Use the edit box to select text programmatically and to validate text values.

Tip For more information about using the numeric edit array control, refer to the *Using the Measurement Studio Windows Forms Control Array .NET Controls* topic in the *NI Measurement Studio Help*.

ASP.NET Web Forms Controls

The Measurement Studio ASP.NET user interface controls are in the Web Forms .NET class library. The Web Forms .NET class library is in the `NationalInstruments.UI.WebForms` namespace. The Web Forms class library encapsulates the following Measurement Studio user interface controls:

- Waveform graph
- Scatter graph
- Digital waveform graph
- Complex graph
- Legend
- Knob
- Gauge
- Meter
- Slide
- Thermometer
- Tank
- Numeric edit
- Switch
- LED
- AutoRefresh

Use this class library to add measurement-specific user interface controls to your Web application. You can configure the controls programmatically at design time or through the Properties window in the Web Forms Designer.

The Measurement Studio ASP.NET Web Forms controls are designed to provide a rich user interface experience through the web browser. The browsers are divided into two broad categories: uplevel and downlevel. Uplevel browsers include recent versions of Microsoft Internet Explorer and Mozilla Firefox. All other browsers are downlevel browsers.

The following sections describe each of the Measurement Studio Web Forms user interface controls.

Waveform Graph and Scatter Graph Controls

Use the Measurement Studio waveform graph and scatter graph controls, as shown in Figure 2-12, to display two-dimensional data on a Web-based user interface. Use the waveform graph to display two-dimensional linear data. You explicitly specify each value in one dimension and provide an initial value and interval to implicitly specify the values in the other dimension. Use the scatter graph to display two-dimensional linear or nonlinear data. You explicitly specify each value in both dimensions.

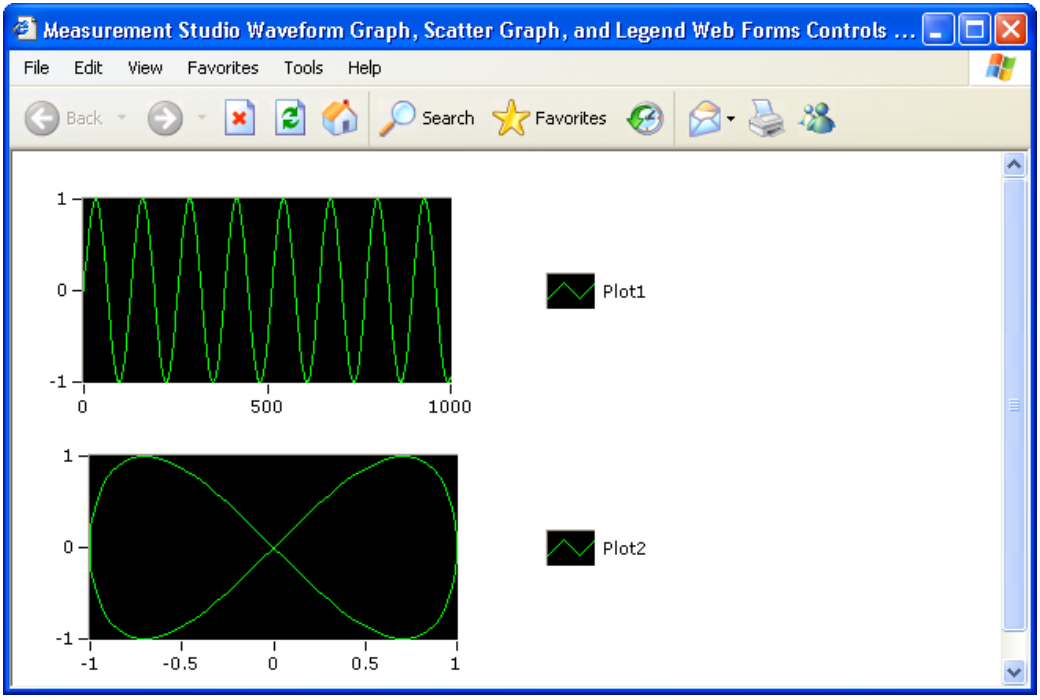


Figure 2-12. Web Forms Waveform Graph and Scatter Graph Controls; Both Graphs Have Corresponding Legends

With the waveform graph and scatter graph controls and the classes that interface with the controls, you can perform the following operations:

Plot Operations

- Plot and chart data.
- Configure a graph to contain multiple plots to show separate but related data on the same graph.
- Draw lines or fills from a plot to an X value, Y value, or another plot.

- Specify plots in the scatter graph control as X and Y data. Specify plots in the waveform graph control as X or Y data and optionally with date and time scaling.
- Use the extensible plot and plot area drawing capabilities and events to customize the graph appearance.
- Create custom point and line styles for plots.
- Specify anti-aliased plots for plot lines.

Axis Operations

- Configure a graph to include multiple axes or independent ranges so that plot data fits the graph plot area.
- Configure the axis modes to fixed, exact autoscaling, loose autoscaling, strip chart, or scope chart.
- Use logarithmic axes with configurable bases.
- Interactively change the range of an axis and invert the axis at run time by clicking on the axis end labels.

Cursor Operations

- Use cursors to identify key points in plots and the plot area.
- Configure cursor snap modes to be floating, nearest point, or to plot.
- Use cursor labels to display X and Y data coordinates that the cursor crosshair points to, and customize the text font and colors of the label.
- Create custom point and line styles for cursors.

Annotation Operations

- Configure text labels, arrows, and drawing shapes to annotate a point anywhere in the plot area of the graph.
- Configure range area, text labels, and arrows to annotate a range in the plot area of the graph.

Additional Operations

- Zoom interactively.
- Specify the image format of the control as BMP, GIF, JPEG, or PNG.
- Configure major, minor, and custom divisions and origin lines.

Tip For more information about using the waveform and scatter graph controls, refer to the *Using the Measurement Studio Web Forms Scatter and Waveform Graph .NET Controls* section in the *NI Measurement Studio Help*.

Digital Waveform Graph Control

Use the Measurement Studio digital waveform graph control, as shown in Figure 2-13, to display `DigitalWaveform` data in an ASP.NET Web application.

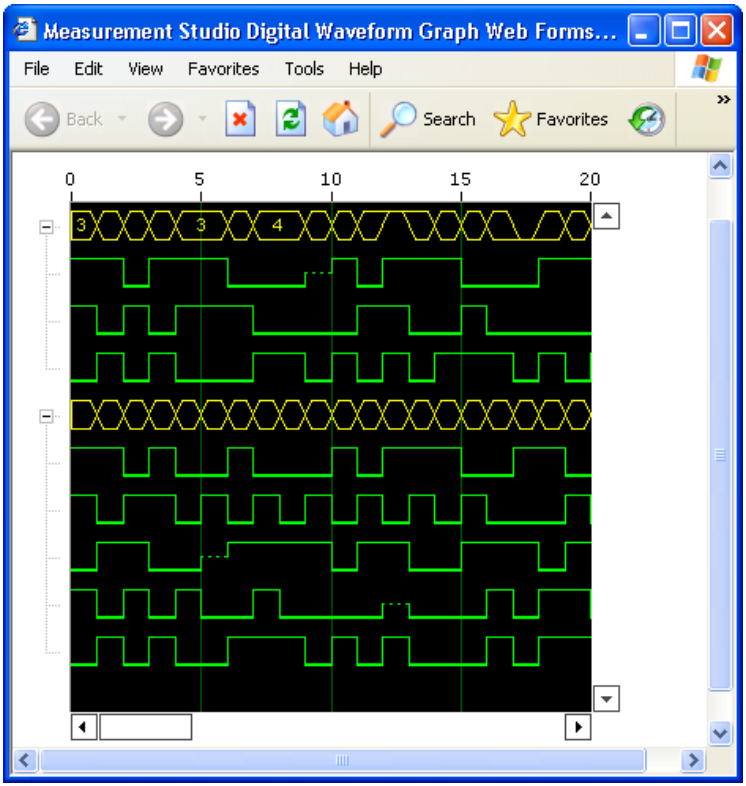


Figure 2-13. Web Forms Digital Graph Control

With the digital waveform graph control and the classes that interface with the control, you can perform the following operations:

Plot Operations

- Plot digital waveform data, including digital signal state data and timing information.
- Configure plot labels on the y-axis.
- Configure plot templates to customize plots that are implicitly created from plotted data.
- Specify anti-aliased digital plots.
- Expand and collapse signal plots interactively.

Waveform Sample and Signal State Operations

- Simultaneously display waveforms and signals or display signals only.
- Create custom waveform sample and signal state styles.
- Configure waveform sample and signal state labels.
- Create custom waveform sample and signal state labels.

Axis Operations

- Configure the axis modes to fixed, exact autoscaling, or loose autoscaling.
- Interactively change the range of an axis and invert the axis at run time by clicking on the axis end labels.

Additional Operations

- Display data in sample or time mode.
- Configure the style and mode of scroll bars.
- Create custom scroll bars.
- Zoom interactively.
- Specify the image format of the control as BMP, GIF, JPEG, or PNG.
- Configure major, minor, and custom divisions.

Tip For more information about using the digital waveform graph control, refer to the *Using the Measurement Studio Web Forms Digital Waveform Graph .NET Control* section in the *NI Measurement Studio Help*.

Complex Graph Control

Use the Measurement Studio complex graph control, as shown in Figure 2-14, to display `ComplexDouble` data on a ASP.NET Web application. A `ComplexDouble` consists of a real part and an imaginary part.

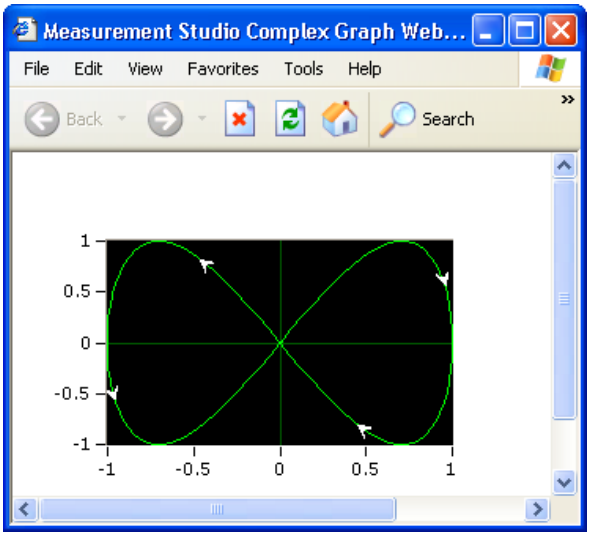


Figure 2-14. Web Forms Complex Graph Control

With the complex graph control and the classes that interface with the control, you can perform the following operations:

Plot Operations

- Plot and chart `ComplexDouble` data.
- Configure a graph to contain multiple plots to show separate but related data on the same graph.
- Draw lines or fills from a plot to an X value, Y value, or another plot.
- Use the extensible plot and plot area drawing capabilities and events to customize the graph appearance.
- Configure the plot to display arrows. The arrows indicate the direction of the complex data.
- Create custom point and line styles for plots.
- Specify anti-aliased plots for plot lines.

Axis Operations

- Configure a graph to include multiple axes or independent ranges so that plot data fits the graph plot area.
- Configure the axis modes to fixed, exact autoscaling, loose autoscaling, strip chart, or scope chart.
- Interactively change the range of an axis and invert the axis at run time by clicking on the axis end labels.

Additional Operations

- Zoom interactively.
- Specify the image format of the control as BMP, GIF, JPEG, or PNG.
- Configure major, minor, and custom divisions and origin lines.

Tip For more information about using the complex graph control, refer to the *Using the Measurement Studio Web Forms Complex Graph .NET Control* section in the *NI Measurement Studio Help*.

Legend Control

Use the Measurement Studio legend control, as shown in Figure 2-12, to display symbols and descriptions for a specific set of elements of another object, such as the plots or cursors of a graph. When you associate the legend control with another object, any changes you make to that object are automatically reflected in the legend. For example, if you associate the legend control with the plots of a graph, any changes you make in the plots collection editor are automatically reflected in the legend.

Tip For more information about using the legend control, refer to the *Using the Measurement Studio Web Forms Legend .NET Control* section in the *NI Measurement Studio Help*.

Numeric Controls

Use the Measurement Studio numeric controls to display numerical information, in an ASP.NET Web application, with the look of scientific instruments. The numeric controls include a knob, gauge, meter, slide, thermometer, and tank. The following sections describe operations available with the controls and the classes that interface with them.

With all of the numeric controls and the classes that interface with them, you can perform the following operations:

- Configure the scale to be linear or logarithmic and toggle the visibility of the scale.
- Fill the scale and configure the range, color, dimensions, and style of the fill.
- Connect to a Measurement Studio .NET numeric edit control so that if you change the value of one control, it changes the value of the other control.
- Customize the appearance of the control using 3D lab styles or classic 2D styles and change the color and length of ticks and labels.
- Configure the format of value labels to engineering or date/time.
- Specify the image format of the control as BMP, GIF, JPEG, or PNG.
- Interactively change the range of an axis and invert the axis at run time by clicking on the axis end labels.

Use the Measurement Studio knob, gauge, and meter controls, as shown in Figure 2-15, to input and display numeric data on your user interface.

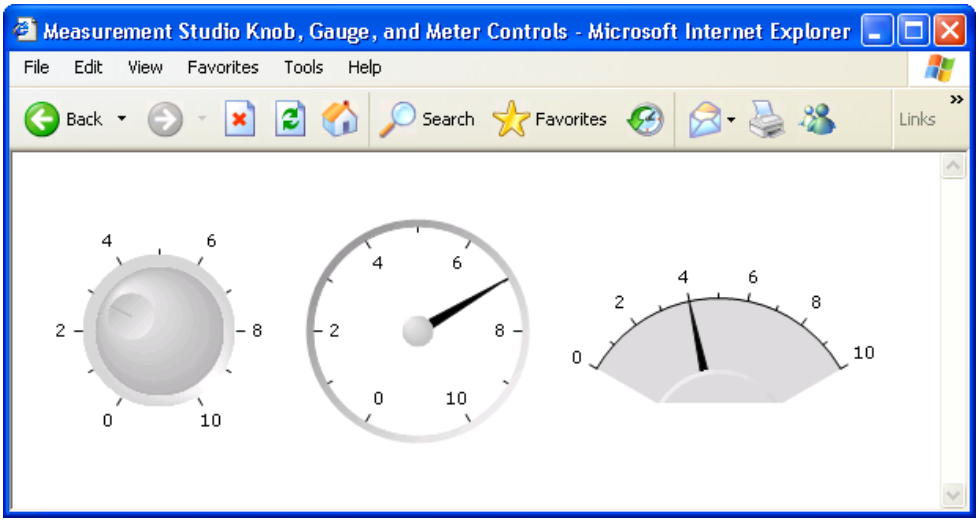


Figure 2-15. Web Forms Knob, Gauge, and Meter Controls

With the knob, gauge, and meter controls and the classes that interface with the controls, you can perform the following operations:

- Specify the start and sweep angle of the arc programmatically or from the Properties window.
- Use automatic division spacing, custom divisions, and invert the scale.

Use the Measurement Studio slide, tank, and thermometer controls, as shown in Figure 2-16, to input and display numeric data on your interface.

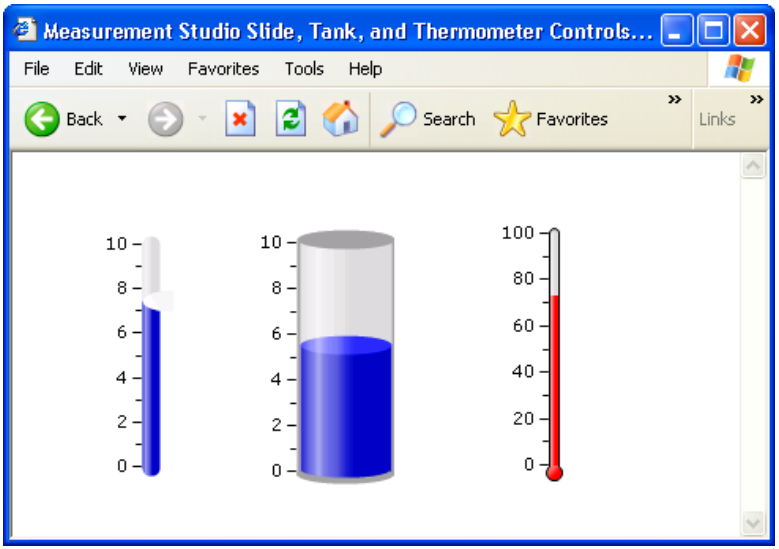


Figure 2-16. Web Forms Slide, Tank, and Thermometer Controls

With the slide, tank, and thermometer controls and the classes that interface with them, you can perform the following operations:

- Fill to the minimum or maximum value of the scale.
- Position the scale horizontally with left, right, or both and position the scale vertically with top, bottom, or both.

Tip For more information about using the Web Forms knob, gauge, meter, slide, tank, or thermometer controls, refer to the *Knob*, *Gauge*, *Meter*, *Slide*, *Tank*, or *Thermometer Class* sections in the *NI Measurement Studio Help*.

Numeric Edit Control

Use the Measurement Studio numeric edit control, as shown in Figure 2-17, to display numeric values and to provide a way by which end users can edit numeric values. Typically, you use a numeric edit control to input or display double numerical data instead of using a Web Forms TextBox control.

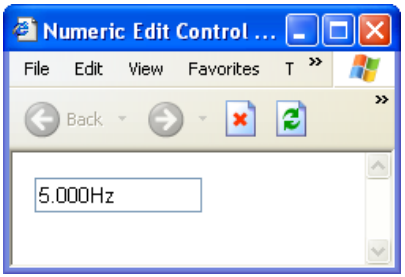


Figure 2-17. Web Forms Numeric Edit Control

With the numeric edit control and the classes that interface with the control you can perform the following operations:

- Perform range checking.
- Set the minimum range value to negative infinity and the maximum range value to positive infinity.
- Create custom formats or use built-in numeric formats including generic, engineering, and simple double.
- Connect to a Measurement Studio numeric control so that if you change the value of one control, it changes the value of the other control.
- Set the coercion mode property to discrete or continuous values. This property configures the control to allow entry or display of either a discrete set of values or any value.
- Validate and format data without posting back to the Web server.

Tip For more information about using the Web Forms numeric edit control, refer to the *NumericEdit Class* section in the *NI Measurement Studio Help*.

Switch and LED Controls

Use the Measurement Studio switch and LED controls as Boolean controls in an ASP.NET Web application. You typically use a switch control to receive and control Boolean input in an ASP.NET Web application. You typically use an LED control to indicate a Boolean value in an ASP.NET Web application. The switch and LED controls are shown in Figure 2-18.

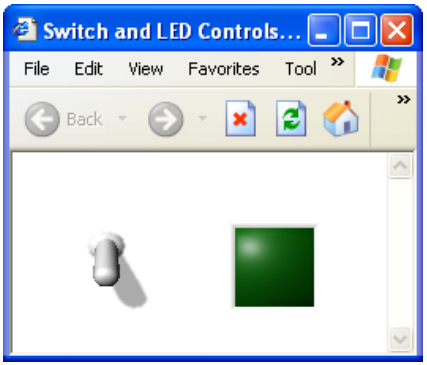


Figure 2-18. Web Forms Switch Control in Vertical Toggle 3D Style and Web Forms LED Control in Square 3D Style

With the switch and LED controls and the classes that interface with the controls, you can perform the following operations:

- Receive notification before or after the state of the control changes.
- Specify the image format of the control as BMP, GIF, JPEG, or PNG.

Tip For more information about using the switch and LED controls, refer to the *Using the Measurement Studio Web Forms Switch and LED .NET Controls* section in the *NI Measurement Studio Help*.

AutoRefresh Control

Use the AutoRefresh control to update a Web control or a group of Web controls on the client at a specified interval.

The AutoRefresh control renders JavaScript on the client to create a timer in the browser. When the timer elapses, the AutoRefresh updates the controls in the AutoRefresh group. For downlevel browsers, the controls update via postback. For uplevel browsers, the client-side script rendered by the AutoRefresh control uses a client callback to update the associated controls on the client without posting the page back to the server.

3

Measurement Studio Integrated Tools and Features

When you use Measurement Studio in the Visual Studio environment, you have access to measurement and automation tools and features for.NET Windows and ASP.NET. These integrated tools and features are designed to help you quickly and easily build measurement and automation applications. These integrated tools are included in support for both Visual Studio .NET 2003 and Visual Studio 2005.

This chapter includes the following sections to help you develop applications with Measurement Studio:

- *Measurement Studio Menu*
- *Creating a Measurement Studio Project*
- *Adding or Removing Measurement Studio Class Libraries*

Refer to the *Developing with Measurement Studio* section in the *NI Measurement Studio Help* for more information about the functionality of these tools and features.

Measurement Studio Menu

The Measurement Studio menu provides an easy way to access the following National Instruments resources and tools:

- **Add/Remove Class Libraries Wizard**—Use the Measurement Studio Add/Remove Class Libraries wizard to add or remove Measurement Studio class libraries or assemblies in existing Visual Basic .NET and Visual C# projects. Select **Measurement Studio» View .NET Class Library Wizard** to access this menu item in Visual Studio 2005.
- **Measurement Computing»InstaCal**—Use *Insta*Cal to configure, calibrate, and test Measurement Computing hardware.
- **MCC Tools»GPIBConfig**—Use GPIBConfig to configure Measurement Computing GPIB hardware. Select **MCC Tools» GPIBConfig** to access this menu item in Visual Studio 2005.

- **Instrument Driver Network**—Use the NI Instrument Driver Network at `ni.com/idnet` as a central resource for downloading, developing, and submitting instrument drivers. Select **Measurement Studio Online Resources»Instrument Driver Network** to access this menu item in Visual Studio 2005.
- **NI Measurement Studio Help**—Use the *NI Measurement Studio Help* to access detailed Measurement Studio help, including function reference, walkthroughs, and conceptual topic documentation on developing with Measurement Studio..
- **Preferences**—Use the Measurement Studio Preferences dialog box to configure Measurement Studio settings, such as conversion options and add-in preferences. Select **Tools»Options** to access this menu item in Visual Studio 2005.
- **Patents**—Use the Patents dialog box to view information about NI patents.
- **Licenses**—Use the Licenses dialog box to view information about NI licenses.
- **About NI Measurement Studio**—Use the NI Measurement Studio About box to view version information.

Tip For more information about the resources included in the Measurement Studio menu, refer to the *Measurement Studio Menu* topic in the *NI Measurement Studio Help*.

Creating a Measurement Studio Project

Measurement Studio includes class library and application templates that you can use to quickly create measurement applications with Visual Basic .NET, Visual C#, and ASP.NET. Refer to Chapter 4, *Getting Started with Measurement Studio*, for step-by-step instructions on how to create a Measurement Studio project. Use the Visual Studio New Project dialog box, as shown for Visual Studio 2005 in Figure 3-1, to access these templates and to create projects. You can create the following projects in Measurement Studio:

- Measurement Studio Visual Basic .NET project
- Measurement Studio Visual C# project
- Measurement Studio ASP.NET project

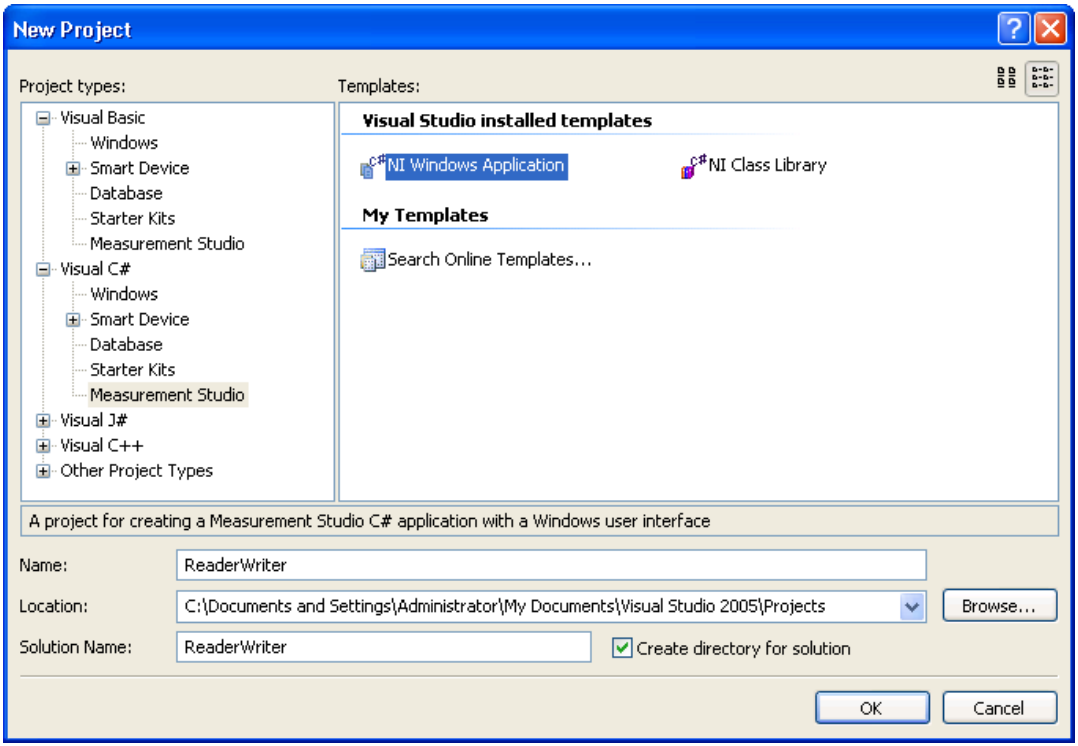


Figure 3-1. New Project dialog box in Visual Studio 2005

Tip For more information about using project templates to create a new Measurement Studio project, refer to the *Creating a New Measurement Studio Project* section in the *NI Measurement Studio Help*.

Adding or Removing Measurement Studio Class Libraries

To add or remove Measurement Studio class libraries from a project, use the Measurement Studio Add/Remove Class Libraries wizard on the Measurement Studio menu. This wizard provides an interface, as shown in Figure 3-2, that you can use to select the Measurement Studio class libraries you want to add to or remove from a project.

When you exit the wizard, the wizard adds or removes the appropriate references to or from the project, thus adding or removing the functionality associated with the class library.

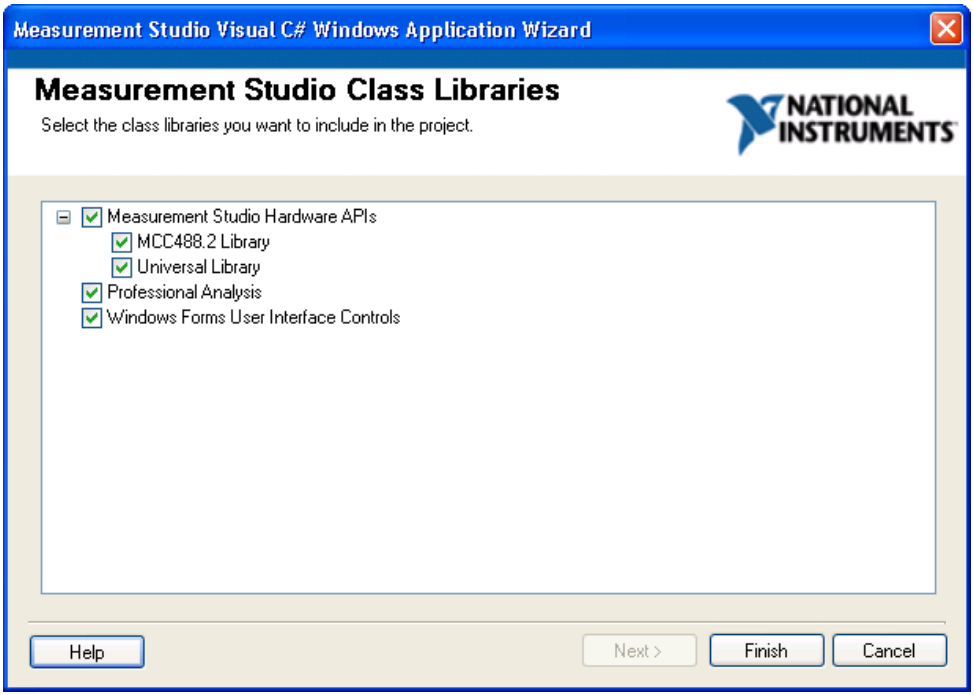


Figure 3-2. Measurement Studio Add/Remove Class Libraries Wizard for Visual Studio 2005

Tip For more information about using the Add/Remove Class Libraries wizard to add or remove Measurement Studio class libraries, refer to the *Adding or Removing Measurement Studio Class Libraries* section in the *NI Measurement Studio Help*.

4

Getting Started with Measurement Studio

The following sections include overview information and step-by-step instructions on developing applications with Measurement Studio tools and features. Refer to the *Developing with Measurement Studio* section and the *Getting Started with the Measurement Studio Class Libraries* section of the *NI Measurement Studio Help* for more information about the functionality of these tools and features.

Measurement Studio Walkthroughs for Visual Studio .NET 2003

Use the following walkthroughs to help you develop applications with Measurement Studio in Visual Studio .NET 2003:

- *Walkthrough: Creating a Measurement Studio Application with Windows Forms Controls and Analysis in Visual Studio .NET 2003*
- *Walkthrough: Creating a Measurement Studio Measurement Computing DAQ Application in Visual Studio .NET 2003*
- *Walkthrough: Creating a Measurement Studio MCCDaq Scan Components Application in Visual Studio .NET 2003*
- *Walkthrough: Creating a Measurement Studio MCC-488.2 Application in Visual Studio .NET 2003*

Walkthrough: Creating a Measurement Studio Application with Windows Forms Controls and Analysis in Visual Studio .NET 2003

Measurement Studio includes user interface controls, such as a waveform graph control and a gauge control, and analysis functionality such as signal generation and mathematical functions. This walkthrough is designed to help you learn how to add analysis and presentation functionality to a Windows Forms application by taking you through the following steps:

- **Setting up the project**—Using the Measurement Studio Application Wizard, you will create a new project that references the Measurement Studio Analysis class library and Windows Forms controls.
- **Adding user interface controls to the project**—Using the Toolbox and the Properties window, you will add and configure user interface controls, including a button, waveform graph, legend, gauge, and numeric edit.
- **Generating, plotting, and analyzing the data**—Using `NationalInstruments.Analysis.SignalGeneration.WhiteNoiseSignal` and `NationalInstruments.Analysis.Math.Statistics.Mean`, you will generate data, plot the generated data on a waveform graph, and calculate the mean of the data.
- **Customizing the user interface**—Using the Collection Editor and Auto Format dialog boxes, you will display the mean value on the gauge and the numeric edit, as well as customize your user interface.

Before You Begin

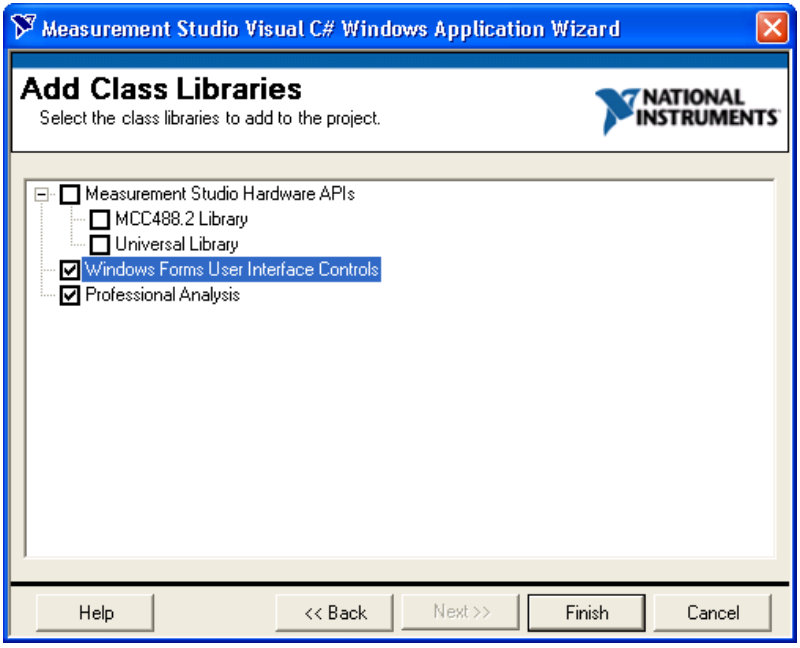
The following components are required to complete this walkthrough:

- Microsoft Visual Studio .NET 2003
- Measurement Studio Measurement Computing Edition

Setting up the project

1. Select **Start»All Programs»Microsoft Visual Studio .NET 2003» Microsoft Visual Studio .NET 2003**.
2. Select **File»New»Project**. The New Project dialog box launches.
3. In the Project Types pane, expand the **Measurement Studio Projects** folder. Select **Visual Basic Projects** or **Visual C# Projects**, depending on which language you want to create the project in.

4. In the Templates pane, select **Windows Application**. Specify `MyMeasurementStudioProject` for **Name** and specify a **Location** of your choice.
5. Click **OK**. The Measurement Studio Application Wizard launches.
6. Select **Analysis** and **Windows Forms User Interface Controls**.

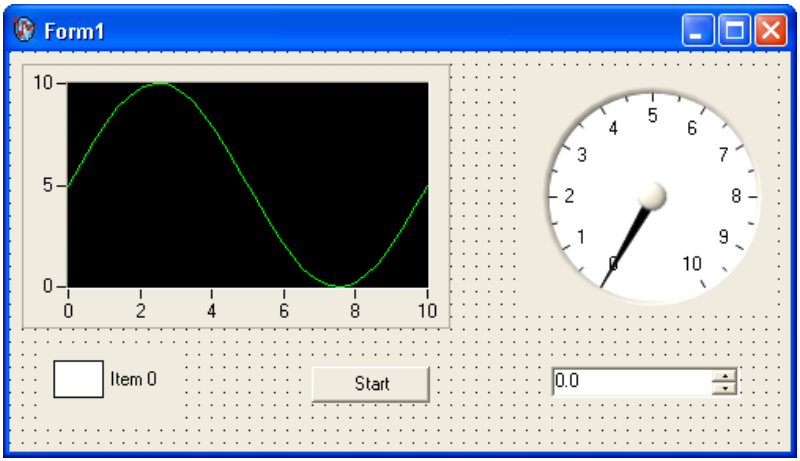


Tip If you are working with an existing project, you can access the Add Class Libraries dialog box by selecting **Measurement Studio»Add/Remove Class Libraries Wizard**.

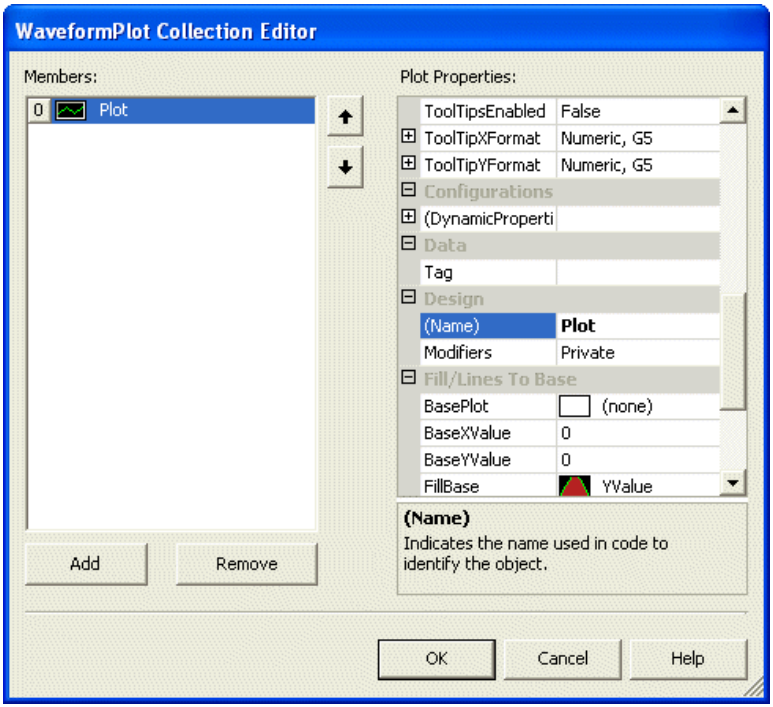
7. Click **Finish** to display `Form1` in the Windows Forms Designer.

Adding user interface controls to the project

In this section, you will build a user interface that looks like `Form1` in the following screenshot.

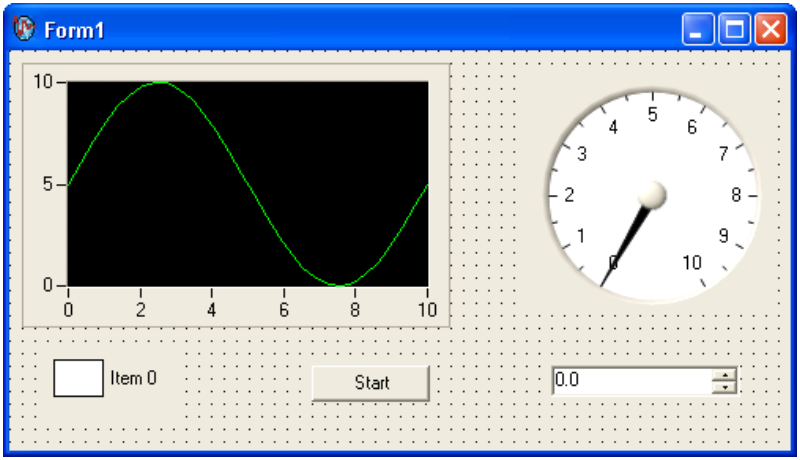


1. Select **View»Toolbox** to display the Toolbox. The Toolbox contains components and controls that you can add to your project.
2. Select the **Windows Forms** tab. The Windows Forms tab contains controls and components included in the `System.Windows.Forms` namespace.
3. Select the **Button** control and drag and drop it onto the form.
4. Right-click the button and select **Properties** to display the Properties window. You configure the properties of the control in the Properties window.
5. The Text property is highlighted. Type `Start` for the button text.
6. Select the **Measurement Studio .NET Tools** tab on the Toolbox.
7. Select the **WaveformGraph** control and drag and drop it onto the form.
8. Right-click the waveform graph and select **Edit Plots** to display the WaveformPlot Collection Editor dialog box. You use the WaveformPlot Collection Editor to add or remove plots and to configure plot properties.



9. Type `Plot` for the Name. Click **OK**.
10. Before you add the legend and gauge controls, you need to resize the form to accommodate them. Select the form and use the double-sided arrow to resize it.
11. Select the **Legend** control and drag and drop it onto the form.
12. Select the **NumericEdit** control and drag and drop it onto the form.
13. Select the **Gauge** control and drag and drop it onto the form.
14. Right-click the gauge and select **Properties** to display the Properties window.
15. Type `gauge` for the name of the gauge.

The following screenshot shows `Form1` with the user controls.



Generating, plotting, and analyzing the data

1. Double-click the button control to display the `Form1` code, with the cursor inside the click event handler of the button control.
2. Add the following code to generate random data, plot the data, calculate the mean of the data, and display the mean on the gauge.

[VB.NET]

```
' Declare and initialize an instance of WhiteNoiseSignal.
Dim whiteNoise As New WhiteNoiseSignal()
' Store the generated data in a double array named data.
Dim data As Double() = whiteNoise.Generate(1000.0, 256)
' Use the PlotY method to plot the data.
Plot.PlotY(data)
' Use the Mean method to calculate the mean of the data.
Dim mean As Double = Statistics.Mean(data)
' Display the mean on the gauge.
gauge.Value = mean
```

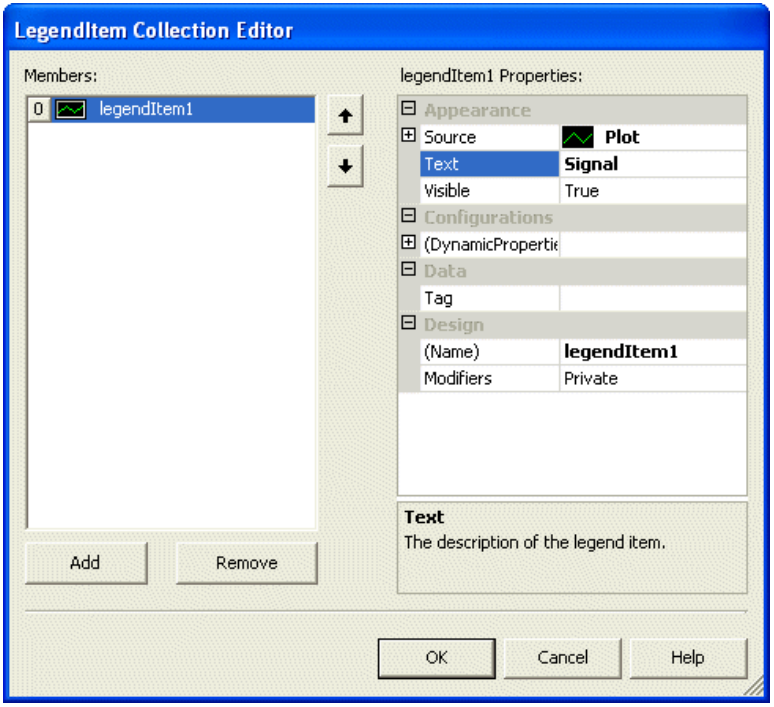
[C#]

```
// Declare and initialize an instance of WhiteNoiseSignal.
WhiteNoiseSignal whiteNoise = new WhiteNoiseSignal();

// Store the generated data in a double array named data.
double[] data = whiteNoise.Generate(1000.0, 256);
```

```
// Use the PlotY method to plot the data.
Plot.PlotY(data);

// Use the Mean method to calculate the mean of the data.
double mean = Statistics.Mean(data);

// Display the mean on the gauge.
gauge.Value = mean;
```

Customizing your user interface

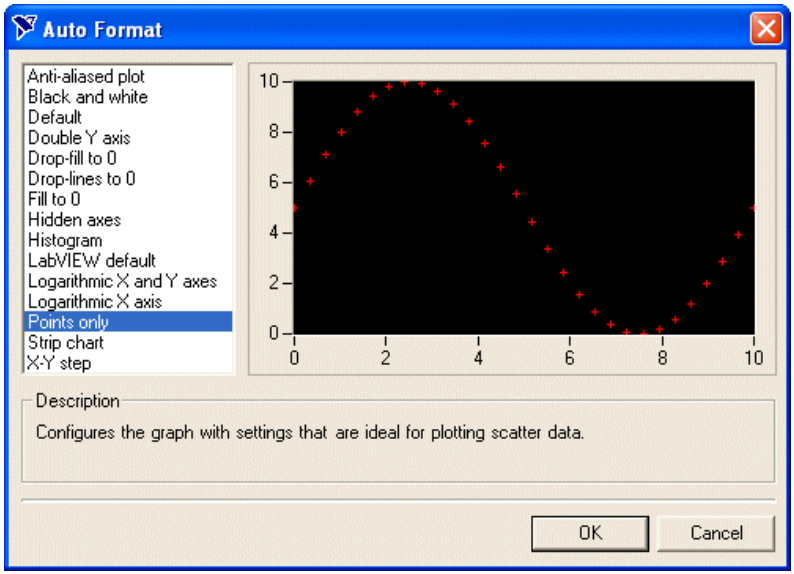
1. Right-click the legend and select **Edit Items** to display the LegendItem Collection Editor dialog box. You use the LegendItem Collection Editor to add or remove legend items and to configure legend item properties.



2. Select **Plot** in the **Source** drop-down list and enter `Signal` in the **Text** box. Click **OK**. Now that you have specified a legend item for the plot, changes you make to the plot will be reflected on the legend.
3. Right-click the graph and select **Auto Format** to display the Auto Format dialog box. The Auto Format dialog box provides a set of pre-configured control styles. When you select a style and click **OK**,

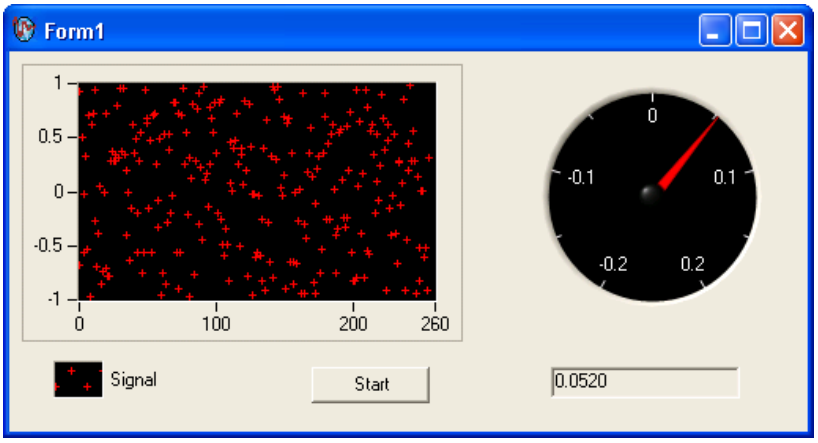
the Auto Format feature configures the appropriate control properties to reflect the style you chose.

4. Select **Points Only**. Click **OK**. Notice that the legend changed automatically to match the formatting of the graph.



5. Right-click the gauge and select **Auto Format** to display the Auto Format dialog box.
6. Select **Dark** and click **OK**.
7. Right-click the gauge and select **Properties** to display the Properties Window.
8. Set the **Range** property for the gauge with the drop-down Range type editor. Type `-0.2` for the minimum value and type `0.2` for the maximum value.
9. Right-click the numeric edit and select **Properties** to display the Properties window.
10. Select **Gauge** in the **Source** drop-down list. Setting the Source property to the gauge allows two-way binding between the controls.
11. Deselect **ArrowKeys**, **Buttons**, and **Text** for the **InteractionMode** property of the numeric edit control. Deselecting these interaction modes makes the numeric edit an indicator. The numeric edit control only displays the calculated mean.

12. Select the Format Mode property and in the Numeric Edit Format Mode Editor dialog box, change the Precision to `4`.
13. Select **File»Save Form1.cs** to save your application.
14. Select **Debug»Start Without Debugging** to run the application.
15. After your program builds and runs, click **Start**. Notice the graph shows the data plot, and the gauge and the numeric edit display the mean of the data.
16. The following screenshot shows `Form1` with customization.



Walkthrough: Creating a Measurement Studio Measurement Computing DAQ Application in Visual Studio .NET 2003

Measurement Studio includes class library and application templates that you can use to quickly create Measurement Computing DAQ applications with Visual Basic .NET and Visual C#. Refer to the following section, *Walkthrough: Creating a Measurement Studio Measurement Computing DAQ Application in Visual Studio .NET 2003*, for step-by-step instructions on how to create a Measurement Studio Measurement Computing DAQ project.

Measurement Studio Measurement Computing Edition includes user interface controls, such as a meter control, and Measurement Computing DAQ functionality such as analog input and digital I/O. This walkthrough is designed to help you learn how to add Measurement Computing DAQ

functionality to a Windows Forms application by taking you through the following steps:

- **Setting up the project**—Using the Visual Studio New Project dialog box, you will create a new project that references the Measurement Studio Measurement Computing DAQ class library and Windows Forms controls.
- **Adding user interface controls to the project**—Using the Toolbox and the Properties window, you will add and configure user interface controls, including a button and meter.
- **Generating and displaying the data**—Using `MccDaq.MccBoard.AIn` and `MccDaq.MccBoard.ToEngUnits`, you will read a raw data point from a channel on an Measurement Computing device, convert the data point to volts, and show the value on a meter.

Before You Begin

The following components are required to complete this walkthrough:

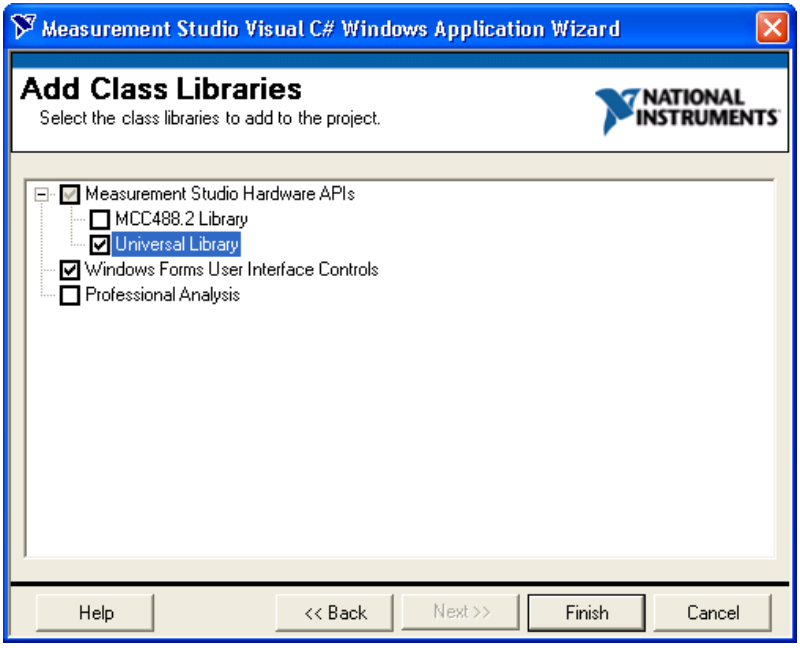
- Microsoft Visual Studio .NET 2003 or Microsoft Visual Studio 2005
- Measurement Studio Measurement Computing Edition
- Universal Library
- Measurement Computing DAQ device

Note For information about installing and configuring your Measurement Computing DAQ device, refer to the *Quick Start Guide* that ships with your device. You can also use the DEMO-BOARD simulated DAQ device to complete this walkthrough.

Setting up the project

1. Select **Start»All Programs»Microsoft Visual Studio .NET 2003» Microsoft Visual Studio .NET 2003**.
2. Select **File»New»Project**. The New Project dialog box launches.
3. In the Project Types pane, expand the **Measurement Studio Projects** folder. Select **Visual Basic Projects** or **Visual C# Projects**, depending on which language you want to create the project in.
4. In the Templates pane, select **Windows Application**. Specify `MyMCCDAQProject` for **Name** and specify a **Location** of your choice.
5. Click **OK**. The Measurement Studio Application Wizard launches.
6. Select **MCC Universal Library** and **Windows Forms User Interface Controls**. When you select these libraries, the Measurement Studio

Application Wizard automatically adds references to the appropriate class libraries.



Tip If you are working with an existing project, you can access the Add Class Libraries dialog box by selecting **Measurement Studio»Add/Remove Class Libraries Wizard**.

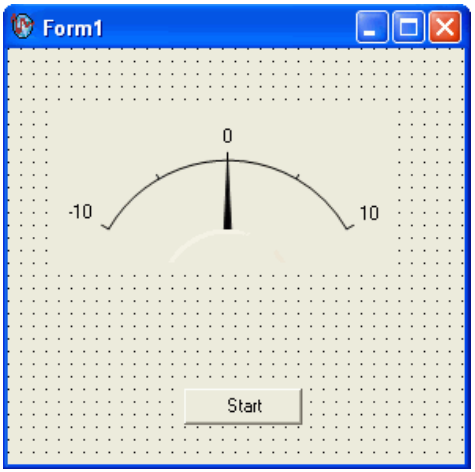
7. Click **Finish** to display `Form1` in the Windows Forms Designer.

Adding user interface controls to the project

1. Select **View»Toolbox** to display the Toolbox. The Toolbox contains components and controls that you can add to your project.
2. Select the **Windows Forms** tab. The Windows Forms tab contains controls and components included in the `System.Windows.Forms` namespace.
3. Select the **Button** control and drag and drop it onto the form.
4. Right-click the button and select **Properties** to display the Properties window. You configure the properties of the control in the Properties window.
5. The Text property will be highlighted. Type `Start` for the button text.
6. Select the **Measurement Studio .NET Tools** tab on the Toolbox.

7. Select the **Meter** control and drag and drop it onto the form.
8. Right-click the meter and select **Properties** to display the Properties window.
9. Set the `CoercionIntervalBase` property for the meter to `-10`.
10. Set the Range property for the meter with the drop-down Range type editor. Type `-10` for the minimum value. Leave the default of `10` for the maximum value.

    The following screenshot shows `Form1` with the user controls.



Generating and displaying the data

1. Double-click on Form1 to display the `Form1` code.
2. Add the following code to declare a new Measurement Computing board object.

[VB.NET]

```
' Declare a new Measurement Computing board object that uses board 0
Public DaqBoard As MccDaq.MccBoard = New MccDaq.MccBoard(0)
```

[C#]

```
private System.Windows.Forms.Button button1;
   private MccDaq.MccBoard daqBoard;
   private NationalInstruments.UI.WindowsForms.Meter meter1;
   /// <summary>
   /// Required designer variable.
   /// </summary>
```

```
  private System.ComponentModel.Container components = null;
  public Form1()
{
  // Required for Windows Form Designer support
  InitializeComponent();
  daqBoard =new MccDaq.MccBoard(0);
```

3. Scroll down to move the cursor inside the click event handler of the button control.
4. Add the following code to read a raw data point from a specified channel on the Measurement Computing device, convert the data to volts, and display the value on the meter.

[VB.NET]

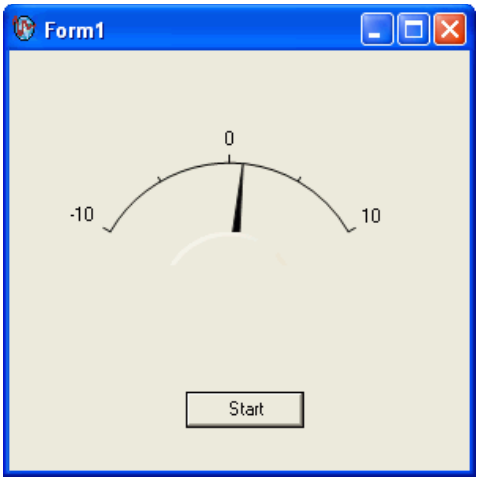
```
'Set channel, range, raw value, and volt variables.
Dim Channel As Integer = 0
Dim Range As MccDaq.Range = MccDaq.Range.Bip10Volts
Dim RawValue As Integer = 0
Dim Volts As Double = 0.0F
' Perform analog input operation with Measurement Computing board,
' channel, and range, and return raw value.
DaqBoard.AIn(Channel, Range, RawValue)
' Convert raw value to engineering units.
DaqBoard.ToEngUnits(Range, RawValue, Volts)
' Display value on meter.
Meter1.Value = Volts
```

[C#]

```
// Set channel, range, raw value, and volt variables.
int channel = 0;
MccDaq.Range range =MccDaq.Range.Bip10Volts;
ushort rawValue =0;
float volts =0.0f;
// Perform analog input operation with Measurement Computing board,
/// channel, and range, and return raw value.
daqBoard.AIn(channel, range, out rawValue);
// Convert raw value to engineering units.
daqBoard.ToEngUnits(range, rawValue, out volts);
// Display value on meter.
meter1.Value =volts;
2003
```

5. Select **File»Save Form1.cs** to save your application.
6. Select **Debug»Start Without Debugging** to run the application.
7. After your program builds and runs, click **Start**. Notice each time you click the Start button, the meter shows the acquired value.

The following screenshot shows `Form1` with the meter displaying the acquired value.



Walkthrough: Creating a Measurement Studio MCCDaq Scan Components Application in Visual Studio .NET 2003

Measurement Studio includes a component library and application templates that you can use to quickly create MccDaq Components applications with Visual Basic .NET and Visual C#.

Measurement Studio Measurement Computing Edition includes user interface controls, such as a waveform graph control, and MccDaq scan components that perform analog input scans and analog output scans. This walkthrough is designed to help you learn how to add analog scan and presentation functionality to a Windows Forms application by taking you through the following steps:

- **Setting up the project**—Using the Visual Studio New Project dialog box, you will create a new project that references the Measurement Studio MccDaq Scan Components library and Windows Forms controls.
- **Adding user interface controls to the project**—Using the Toolbox and the Properties window, you will add and configure user interface controls and `MccDaq.Scan` components, including a button and waveform graph, and an `AiScan` component.

- **Generating and displaying the data**—Using the `MccDaq.Scan` components, you will read data from a channel on an Measurement Computing device, convert the data object to an array, and show the value on a waveform graph.

Before You Begin

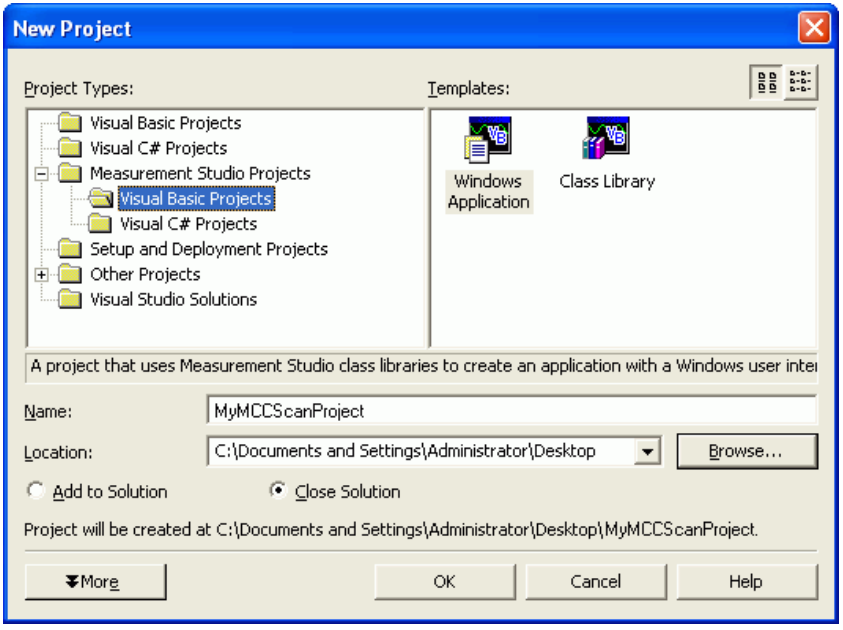
The following components are required to complete this walkthrough:

- Microsoft Visual Studio .NET 2003 or Microsoft Visual Studio 2005
- Measurement Studio Measurement Computing Edition
- MccDaq Scan Components
- Measurement Computing DAQ device

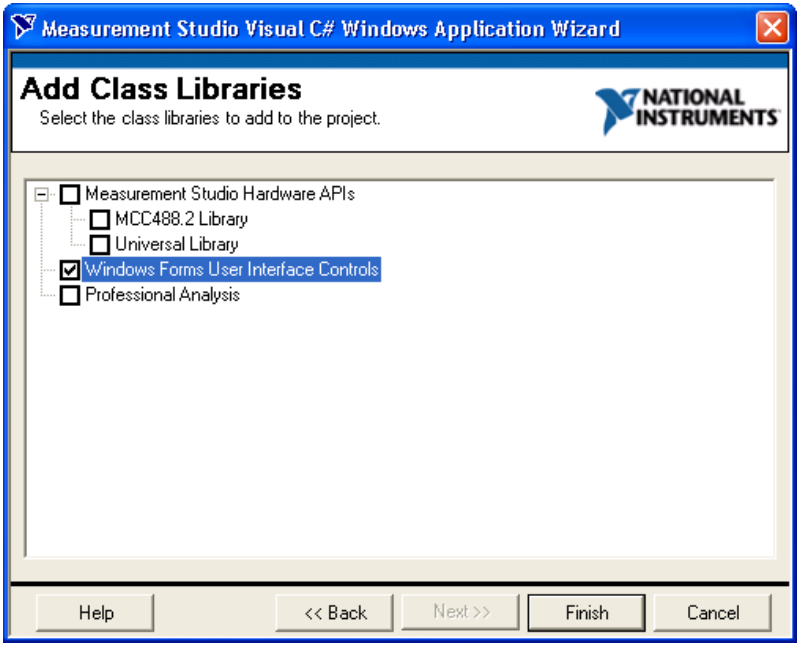
Note For information about installing and configuring your Measurement Computing DAQ device, refer to the *Quick Start Guide* that ships with your device. You can also use the DEMO-BOARD simulated DAQ device to complete this walkthrough.

Setting up the project

1. Select **Start»All Programs»Microsoft Visual Studio .NET 2003» Microsoft Visual Studio .NET 2003**.
2. Select **File»New»Project**. The New Project dialog box launches.



3. In the Project Types pane, expand the **Measurement Studio Projects** folder. Select **Visual Basic Projects** or **Visual C# Projects**, depending on which language you want to create the project in.
4. In the Templates pane, select **Windows Application**. Specify `MyMCCScanProject` for **Name** and specify a **Location** of your choice.
5. Click **OK**. The Measurement Studio Application Wizard launches.
6. Select **Windows Forms User Interface Controls**. When you select this library, the Measurement Studio Application Wizard automatically adds references to the appropriate class libraries.



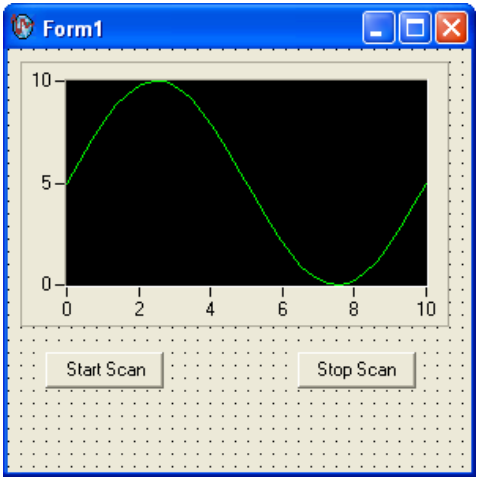
Tip If you are working with an existing project, you can access the Add Class Libraries dialog box by selecting **Measurement Studio»Add/Remove Class Libraries Wizard**.

7. Click **Finish** to display `Form1` in the Windows Forms Designer.

Adding user interface controls to the project

1. Select **View»Toolbox** to display the Toolbox. The Toolbox contains components and controls that you can add to your project.
2. Select the **Windows Forms** tab. The Windows Forms tab contains controls and components included in the `System.Windows.Forms` namespace.
3. Select the **Button** control and drag and drop it onto the form.
4. Right-click the button and select **Properties** to display the Properties window. You configure the properties of the control in the Properties window.
5. The Text property is highlighted. Type `Start Scan` for the button text.
6. Select another button control and drag and drop it onto the form. Type `Stop Scan` for the button text.
7. Select the **Measurement Studio .NET Tools** tab on the Toolbox.
8. Select the **Waveform graph** control and drag and drop it onto the form.
9. Double-click the **AIScan** component (`aiScan1`) to add it to the component tray beneath the form.
10. Right-click the **AIScan** component (`aiScan1`) and select **Properties** to display the Properties window.
11. Click on the **ClockRate** property and type `500` for this property setting.

The following screenshot shows `Form1` with the user controls. The `AIScan` component is shown in the component tray.



Generating and displaying the data

1. Double-click the **Start** button to display the `Form1` code.
2. Add the following line of code to start an analog in scan.

[VB.NET]

```
' This starts the scan
AIScan1.Start()
```

[C#]

```
// This starts the scan
private void button1_Click(object sender, System.EventArgs e)
{
aiScan1.Start();
}
```

3. Double-click on the Stop Scan button to open the code window.
4. Add the following line of code that stops the analog in scan.

[VB.NET]

```
' This stops the scan
AiScan1.Stop()
```

[C#]

```
// This stops the scan
private void button2_Click(object sender, System.EventArgs e)
{
    aiScan1.Stop();
}
```

5. Double-click the `AIScan` component to open the code window.
6. Add the following lines of code to the `DataReady` event of the `aiScan1` component to copy the analog data to an array.

[VB.NET]

```
Private Sub AiScan1_DataReady(ByVal sender As Object, ByVal e As System.Even-
tArgs) Handles AiScan1.DataReady

WaveformGraph1.PlotY(AiScan.GetSingleChannelValues(), 0, 1.0 /
AiScan1.ActualRate)
```

[C#]

```
private void aiScan1_DataReady(object sender, System.EventArgs e)

{

waveformGraph1.PlotY(AiScan.GetSingleChannelValues(), 0,
1.0/aiScan1.ActualRate);

}
```

7. Add the following lines of code to the `ErrorOccurred` event of the `aiScan1` component to display a message box if an error occurs.

[VB.NET]

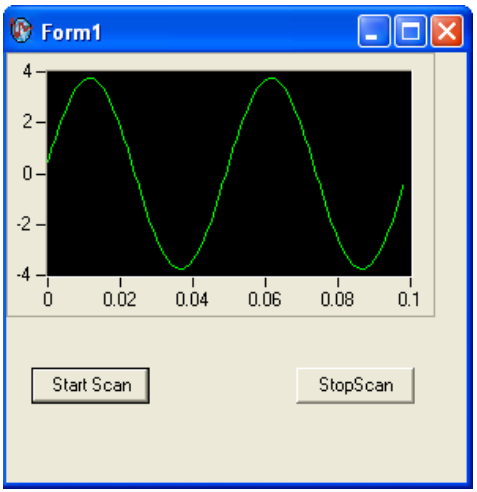
```
Private Sub AiScan1_ErrorOccurred(ByVal sender As Object, ByVal e As
MccDaq.ScanComponents.ErrorOccurredEventArgs) Handles AiScan1.ErrorOccurred
AiScan1.Stop()
MessageBox.Show(AiScan1.Status, "AI Scan Error")
End Sub
```

[C#]

```
private void aiScan1_ErrorOccurred(object sender,
MccDaq.ScanComponents.ErrorOccurredEventArgs e)
{
    aiScan1.Stop();
    MessageBox.Show(aiScan1.Status, "AI Scan Error");
}
```

8. Select **File»Save Form1.cs** to save your application.
9. Select **Debug»Start Without Debugging** to run the application.
10. After your program builds and runs, click **Start Scan**.

The following screenshot shows `Form1` with the waveform graph displaying the acquired values.



Walkthrough: Creating a Measurement Studio MCC-488.2 Application in Visual Studio .NET 2003

- **Setting up the project**—Using the Visual Studio New Project dialog box, you will create a new project that references the Measurement Studio MCC-488.2 class library and Windows Forms controls.
- **Adding user interface controls to the project**—Using the Toolbox and the Properties window, you will add and configure user interface controls, including a button and waveform graph.
- **Generating and displaying data**—Using `MCC.488.2.Device` and `MCC.488.2.Address`, you will read and plot 100 data points data point from a GPIB device at the specified address.

Before You Begin

The following components are required to complete this walkthrough:

- Microsoft Visual Studio .NET 2003 or Microsoft Visual Studio 2005
- Measurement Studio Measurement Computing Edition

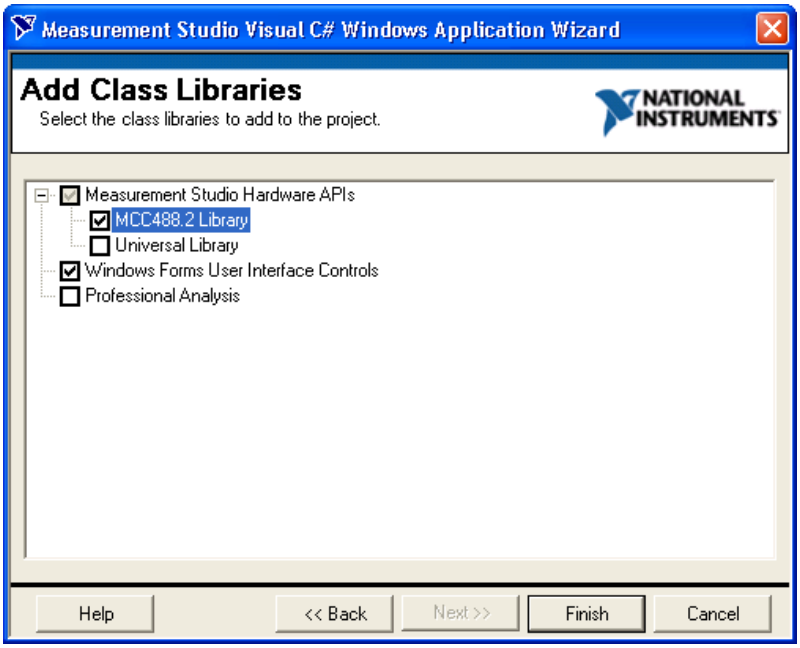
- MCC-488.2 Library
- Measurement Computing GPIB Device

Setting up the project

1. Open Visual Studio .NET from **Start»All Programs»Microsoft Visual Studio .NET 2003»Microsoft Visual Studio .NET 2003**.
2. Select **File»New»Project**. The New Project dialog box launches.
3. In the Project Types pane, expand the **Measurement Studio Projects** folder. Select **Visual Basic Projects** or **Visual C# Projects**, depending on which language you want to create the project in. This walkthrough refers to Visual C#, but Visual Basic .NET users can follow the same process.
4. In the Templates pane, select **Windows Application**. Specify `MyMCCGPIBProject` for **Name** and select a **Location** of your choice.
5. Click **OK**. The Measurement Studio Application Wizard launches.

Tip If you are working with an existing project, you can access the Add Class Libraries dialog box by selecting **Measurement Studio»Add/Remove Class Libraries Wizard**.

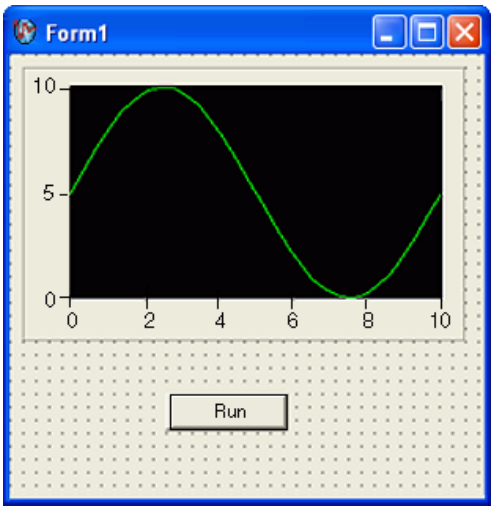
6. In the Application Wizard dialog box, select **Windows Forms User Interface Controls** and **MCC-488.2 Library**. The wizard automatically adds references to the appropriate class libraries and sets up the project for you.



7. Click **Finish** to display Form1 in the Windows Forms Designer.

Adding user interface controls to the project

1. Select **View»Toolbox** to display the Toolbox. The Toolbox contains components and controls that you can add to your project.
2. Select the **Windows Forms** tab. The Windows Forms tab contains controls and components included in the `System.Windows.Forms` namespace.
3. Select the **Button** control and drag and drop it onto the form.
4. Right-click the button and select **Properties** to display the Properties window. You configure the properties of the control in the Properties window.
5. The Text property is highlighted. Type `Run` for the button text.
6. Select the **WaveformGraph** control and drag and drop it onto the form.
7. The following screenshot shows `Form1` with the user controls.



Generating and displaying the data

1. Double-click the **button** control to display the `Form1` code, with the cursor inside the click event handler of the button control.
2. Add the following code to read a raw data point from a specified channel on the Measurement Computing device, convert the data to volts, and display the value on the graph.

[VB.NET]

```
Dim I As Integer
Dim WrtString As String = "val?"
Dim RdBufSize As Integer = 100
Dim NlChar As Char = "\n"
Dim NullChar As Char = "\0"
Dim PrimaryAddress As New Address(2)
Dim BoardNum As Integer = 0
' Open a gpib device
Dim Device As New Device(BoardNum, PrimaryAddress)
' Allocate a buffer to hold the data
Dim Buffer As IntPtr =
System.Runtime.InteropServices.Marshal.AllocHGlobal(RdBufSize)
' Read and plot 100 samples
For I = 0 To 99
' Write the string (val?) to the Fluke45
Device.Write(WrtString)
' Read the response from the Fluke45
Dim S As String = Device.ReadString(RdBufSize)
' Replace the newline character with a null and
```

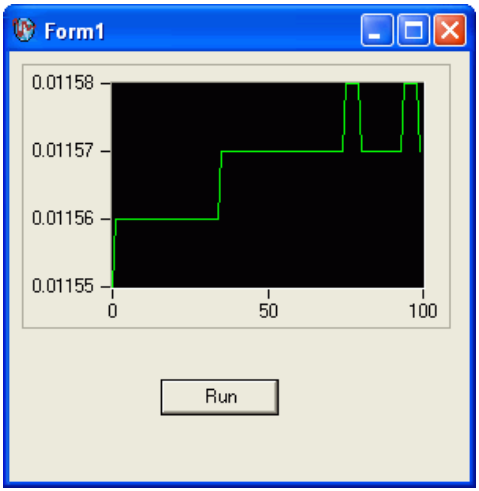
```
' convert the string to a double
Dim D As Double = Convert.ToDouble(S.Replace(NlChar, NullChar))
'Plot the point
WaveformGraph1.PlotYAppend(D, 1)
Next
System.Runtime.InteropServices.Marshal.FreeHGlobal(Buffer)
```

[C#]

```
stringwrtString = "val?";
    int    rdBufSize = 100;
    char   nlChar = '\n';
    char   nullChar = '\0';
    addressprimaryAddress = new Address(2);
    int    boardNum = 0;
// open a gpib device
    Device device = new Device(boardNum, primaryAddress);
// allocate a buffer to hold the data
    IntPtr buffer =
System.Runtime.InteropServices.Marshal.AllocHGlobal(rdBufSize);
// read and plot 100 samples
    for (int i=0; i<100; i++)
    {
        // write the string (val?) to the Fluke45
        device.Write(wrtString);
        // read the response from the Fluke45
        string s = device.ReadString(rdBufSize);
        // replace the newline character with a null and
        // convert the string to a double
        double d = Convert.ToDouble(s.Replace(nlChar, nullChar));
        // plot the point
        waveformGraph1.PlotYAppend(d, 1);
    }
    System.Runtime.InteropServices.Marshal.FreeHGlobal(buffer);
```

3. Select **File»Save Form1.cs** to save your application.
4. Select **Debug»Start Without Debugging** to run the application.
5. After your program builds and runs, click **Run**. Notice each time you click the Run button, the graph shows the acquired value.

The following screenshot shows `Form1` with the graph displaying the acquired value.



Measurement Studio Walkthroughs for Visual Studio 2005

Use the following walkthroughs to help you develop Measurement Studio applications in Visual Studio 2005:

- *Walkthrough: Creating a Measurement Studio Application with Windows Forms Controls and Analysis in Visual Studio 2005*
- *Walkthrough: Creating a Measurement Studio Application with Web Forms Controls and Analysis in Visual Studio 2005*

Note Refer to *Walkthrough: Creating a Measurement Studio MCCDaq Scan Components Application in Visual Studio .NET 2003*, *Walkthrough: Creating a Measurement Studio MCC-488.2 Application in Visual Studio .NET 2003*, and *Walkthrough: Creating a Measurement Studio Measurement Computing DAQ Application in Visual Studio .NET 2003* for more walkthroughs available in Visual Studio 2005.

Walkthrough: Creating a Measurement Studio Application with Windows Forms Controls and Analysis in Visual Studio 2005

Measurement Studio includes user interface controls, such as a waveform graph control and a gauge control, and analysis functionality such as signal generation and mathematical functions. This walkthrough is designed to help you learn how to add analysis and presentation functionality to a Windows Forms application by taking you through the following steps:

- **Setting up the project**—Using the Measurement Studio Application Wizard, you will create a new project that references the Measurement Studio Analysis class library and Windows Forms controls.
- **Adding user interface controls to the project**—Using the Toolbox, smart tags, and the Properties window, you will add and configure a button, waveform graph, legend, gauge, and numeric edit user interface control.
- **Generating, plotting, and analyzing the data**—Using `NationalInstruments.Analysis.SignalGeneration.WhiteNoiseSignal` and `NationalInstruments.Analysis.Math.Statistics.Mean`, you will generate data, plot the generated data on a waveform graph, and calculate the mean of the data.
- **Customizing the user interface**—Using smart tags and the Collection Editor and Auto Format dialog boxes, you will display the mean value on the gauge and the numeric edit, as well as customize your user interface.

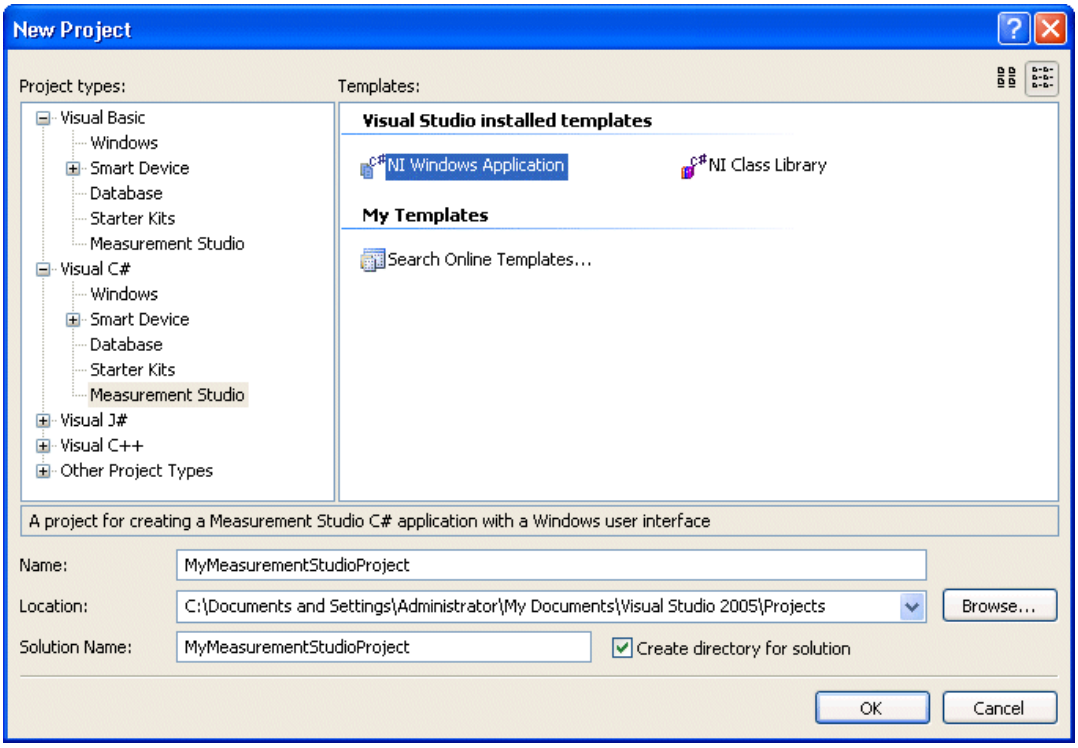
Before You Begin

The following components are required to complete this walkthrough:

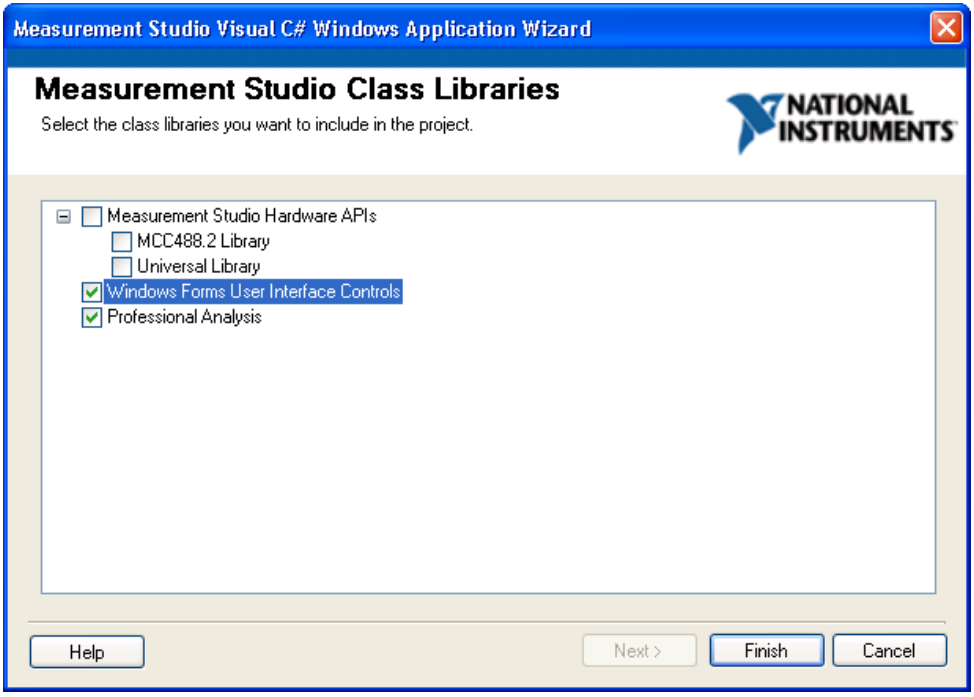
- Microsoft Visual Studio 2005
- Measurement Studio Measurement Computing Edition

Setting up the project

1. Select **Start»All Programs»Microsoft Visual Studio 2005» Microsoft Visual Studio 2005**.
2. Select **File»New»Project**. The New Project dialog box launches.



3. In the Project types pane, select **Measurement Studio** under Visual C# or Visual Basic, depending on which language you want to create the project in.
4. In the Templates pane, select **NI Windows Application**. Specify `MyMeasurementStudioProject` for **Name** and specify a **Location** of your choice.
5. Click **OK**. The Measurement Studio Application Wizard launches.
6. Select **Analysis** and **Windows Forms User Interface Controls**.

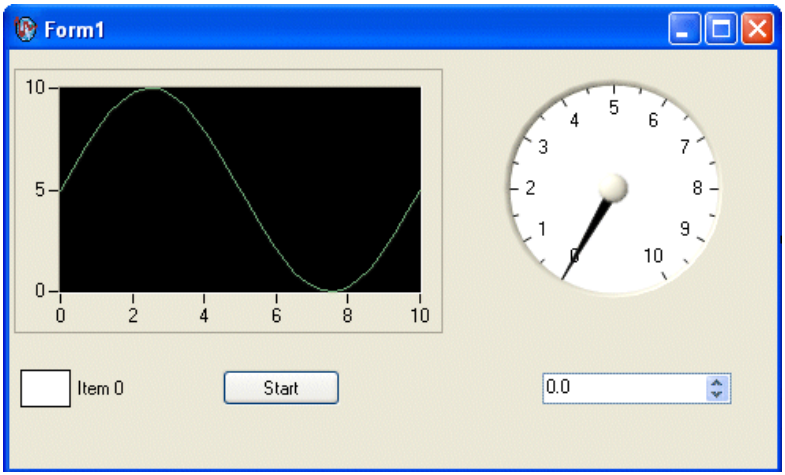


Tip IIf you are working with an existing project, you can access the Add/Remove Class Libraries dialog box by selecting **Measurement Studio»View .NET Class Library Wizard**.

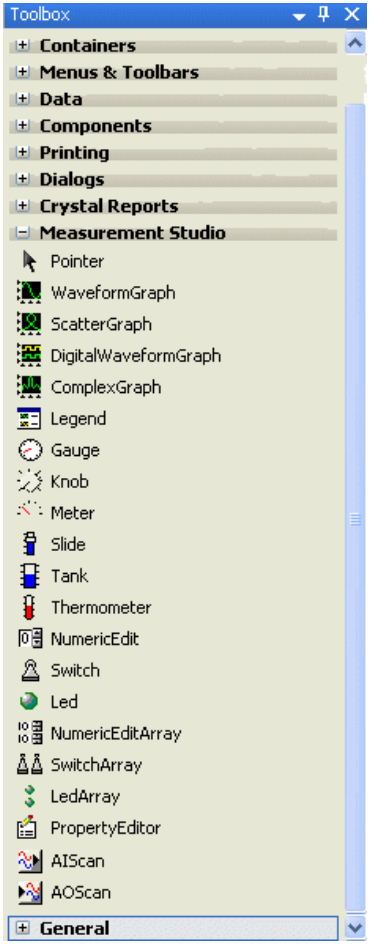
7. Click **Finish** to display `Form1` in the Windows Forms Designer.

Adding user interface controls to the project

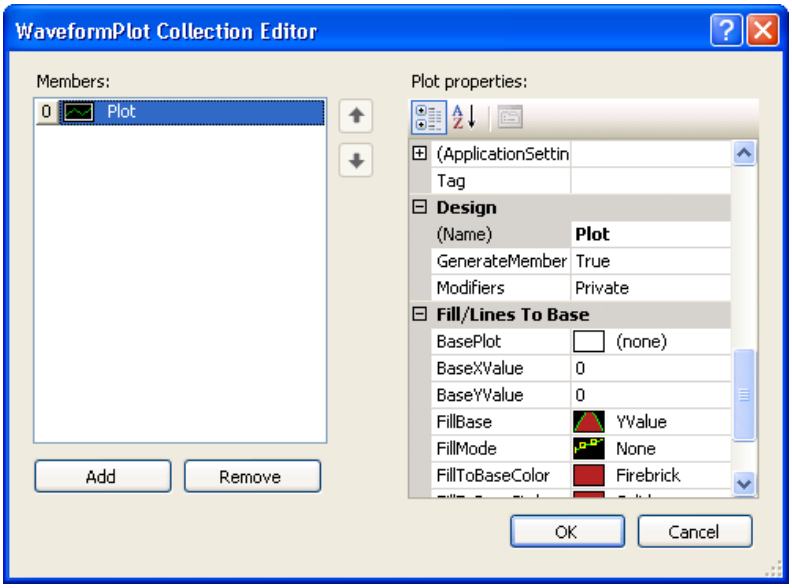
In this section, you will build a user interface that looks like `Form1` in the following screenshot.



1. Select **View»Toolbox** to display the Toolbox. The Toolbox contains components and controls that you can add to your project.
2. Expand the **All Windows Forms** group. The All Windows Forms group contains controls and components included in the `System.Windows.Forms` namespace.
3. Select the **Button** control and drag and drop it onto the form.
4. Right-click the **button** and select **Properties** to display the Properties window. You configure the properties of the control in the Properties window.
5. The Text property is highlighted. Type `Start` for the button text.
6. Expand the **Measurement Studio** group in the Toolbox.

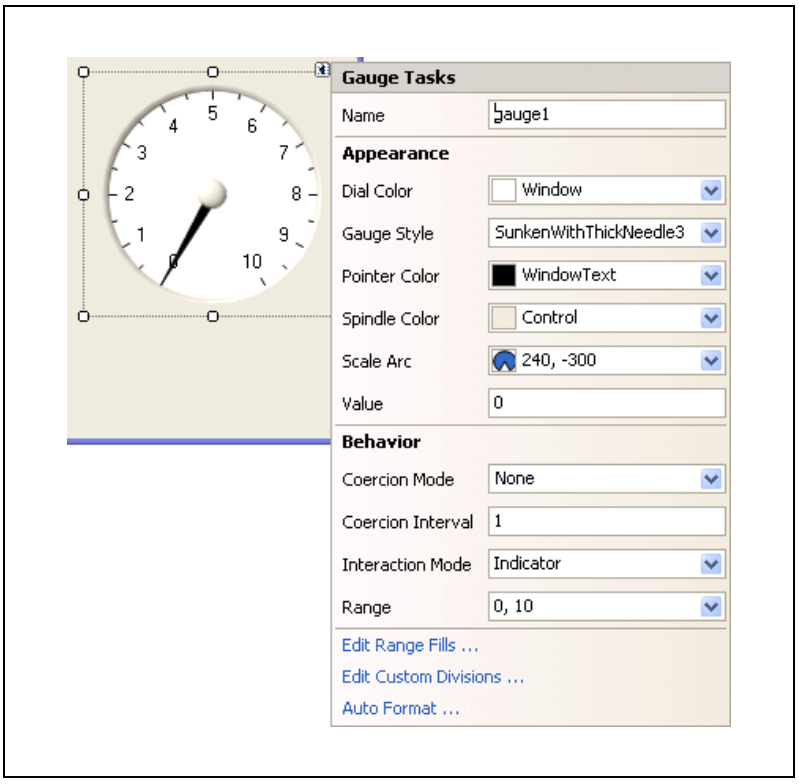


7. Select the **WaveformGraph** control and drag and drop it onto the form.
8. Right-click the **waveform graph** and select **Edit Plots** to display the WaveformPlot Collection Editor dialog box. You use the WaveformPlot Collection Editor to add or remove plots and to configure plot properties.

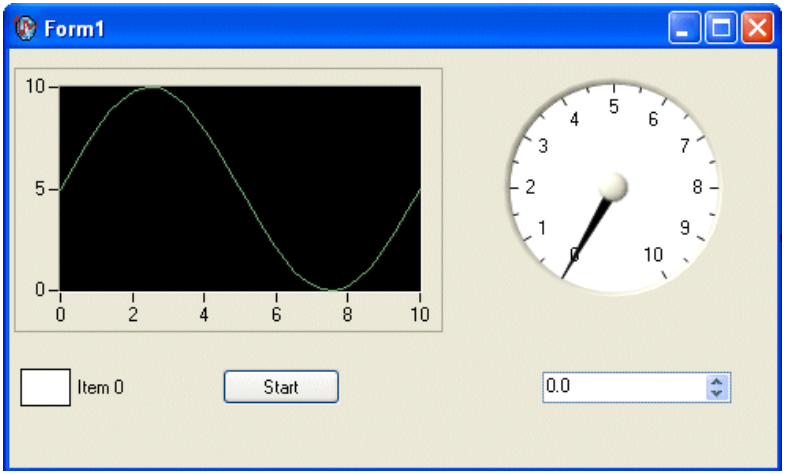


Note You can also access the WaveformPlot Collection Editor dialog box by clicking the waveform graph smart tag. You access the smart tag by right-clicking the arrow button in the upper right corner of the control.

9. Type `Plot` for the Name. Click **OK**.
10. Before you add the Measurement Studio legend, numeric edit, and gauge controls, you need to resize the form to accommodate them. Select the form and use the double-sided arrow to resize it.
11. Select the **Legend** control and drag and drop it onto the form.
12. Select the **NumericEdit** control and drag and drop it onto the form.
13. Select the **Gauge** control and drag and drop it onto the form.
14. Click the gauge smart tag to display the Gauge Tasks. You access the smart tag by right-clicking the arrow button in the upper right corner of the control.
15. Type `gauge` for the name of the gauge.



The following screenshot shows `Form1` with the user controls.



Generating, plotting, and analyzing the data

1. Double-click the button control to display the `Form1` code, with the cursor inside the click event handler of the button control.
2. Add the following code to generate random data, plot the data, calculate the mean of the data, and display the mean on the gauge.

[VB.NET]

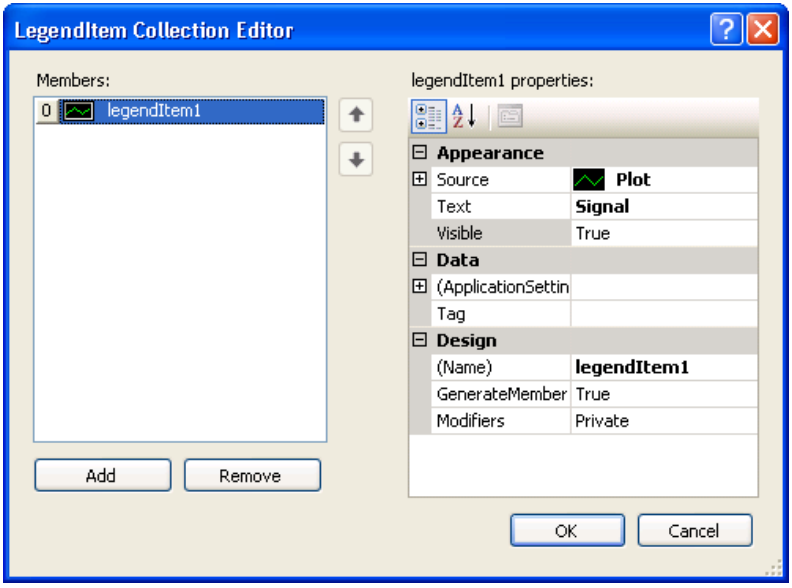
```
' Declare and initialize an instance of WhiteNoiseSignal.
Dim whiteNoise As New WhiteNoiseSignal()
' Store the generated data in a double array named data.
Dim data As Double() = whiteNoise.Generate(1000.0, 256)
' Use the PlotY method to plot the data.
Plot.PlotY(data)
' Use the Mean method to calculate the mean of the data.
Dim mean As Double = Statistics.Mean(data)
' Display the mean on the gauge.
gauge.Value = mean
```

[C#]

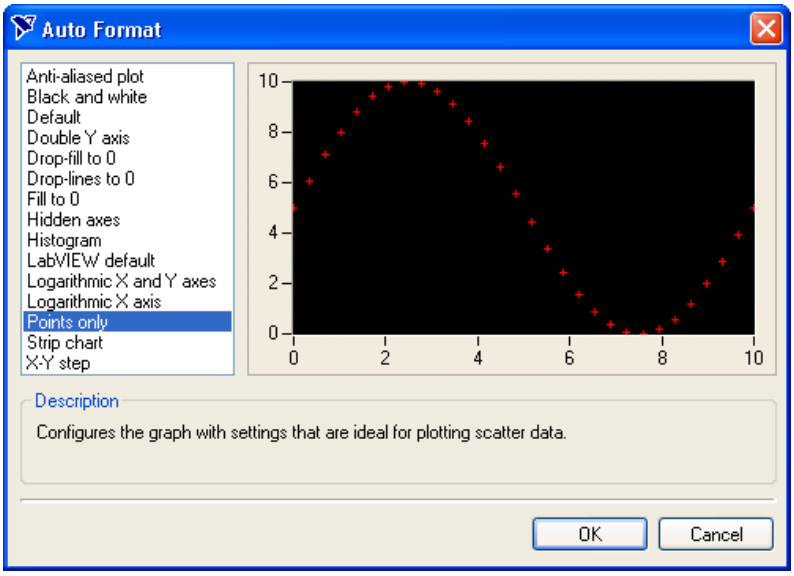
```
// Declare and initialize an instance of WhiteNoiseSignal.
WhiteNoiseSignal whiteNoise = new WhiteNoiseSignal();

// Store the generated data in a double array named data.
double[] data = whiteNoise.Generate(1000.0, 256);


// Use the PlotY method to plot the data.
Plot.PlotY(data);

// Use the Mean method to calculate the mean of the data.
double mean = Statistics.Mean(data);

// Display the mean on the gauge.
gauge.Value = mean;
```

Customizing your user interface

1. Right-click the legend and select **Edit Items** to display the LegendItem Collection Editor dialog box. You use the LegendItem Collection Editor to add or remove legend items and to configure legend item properties.

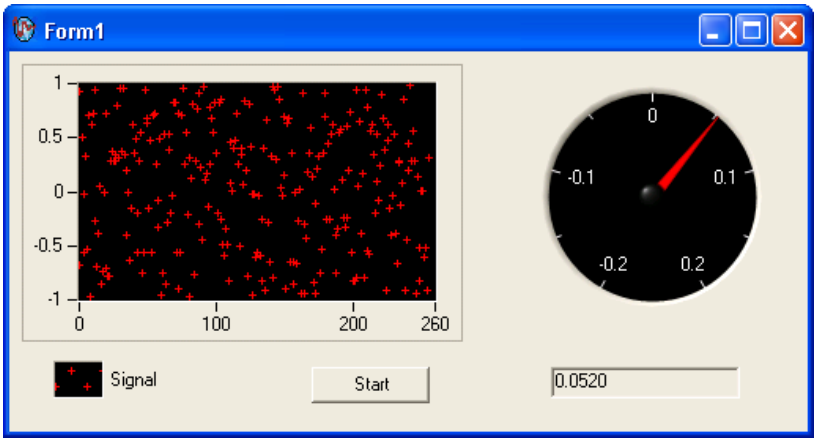


2. Select **Plot** in the **Source** drop-down list and enter `Signal` in the **Text** box. Click **OK**. Now that you have specified a legend item for the plot, changes you make to the plot are reflected on the legend.
3. Right-click the graph and select **Auto Format** to display the Auto Format dialog box. The Auto Format dialog box provides a set of pre-configured control styles. When you select a style and click **OK**, the Auto Format feature configures the appropriate control properties to reflect the style you chose.
4. Select **Points Only**. Click **OK**. Notice that the legend changed automatically to match the formatting of the graph.



5. Click the **gauge smart tag** to display the Gauge Tasks.
6. Select **Auto Format** to display the Auto Format dialog box.
7. Select **Dark** and click **OK**.
8. Right-click the **gauge** and select **Properties** to display the Properties window.
9. Set the Range property for the gauge with the drop-down Range type editor. Type `-0.2` for the minimum value and type `0.2` for the maximum value.
10. Click the **numeric edit smart tag** to display the Numeric Edit Tasks.
11. Select **Gauge** in the **Source** drop-down list. Setting the Source property to the gauge allows two-way binding between the controls.
12. Deselect **ArrowKeys**, **Buttons**, and **Text** for the **InteractionMode** property of the numeric edit control. Deselecting these interaction modes makes the numeric edit an indicator. The numeric edit control only displays the calculated mean.
13. Select the **Format Mode** property and in the Numeric Edit Format Mode Editor dialog box, change the Precision to `4` to show four decimal places of precision.
14. Select **File»Save Form1.cs** to save your application.
15. Select **Debug»Start Without Debugging** to run the application.

16. After your program builds and runs, click **Start**. Notice the graph shows the data plot, and the gauge and the numeric edit display the mean of the data.
17. The following screenshot shows `Form1` with customization.



Walkthrough: Creating a Measurement Studio Application with Web Forms Controls and Analysis in Visual Studio 2005

Measurement Studio includes user interface controls, such as a waveform graph control and a gauge control, and analysis functionality such as signal generation and mathematical functions. This walkthrough is designed to help you learn how to add analysis and presentation functionality to a Web Forms application by taking you through the following steps:

- **Setting up the project**—Using the Measurement Studio Application Wizard, you will create a new project that references the Measurement Studio Analysis class library and Web Forms controls.
- **Adding user interface controls to the project**—Using the Toolbox and the Properties window, you will add and configure a button, waveform graph, legend, gauge, and numeric edit user interface control.
- **Generating, plotting, and analyzing the data**—Using `WhiteNoiseSignal` and `Mean`, you will generate data, plot the generated data on a waveform graph, and calculate the mean of the data.

- **Customizing the user interface**—Using the Collection Editor and Auto Format dialog boxes, you will display the mean value on the gauge and the numeric edit, as well as customize your user interface.

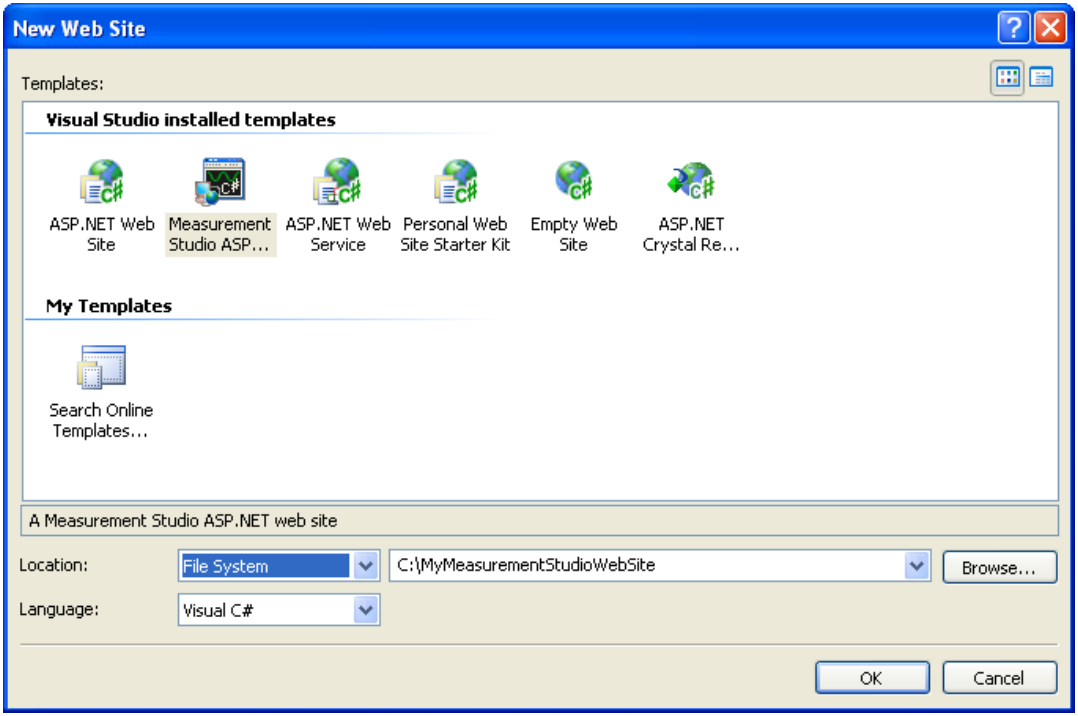
Before You Begin

The following components are required to complete this walkthrough:

- Microsoft Visual Studio 2005
- Measurement Studio Measurement Computing Edition

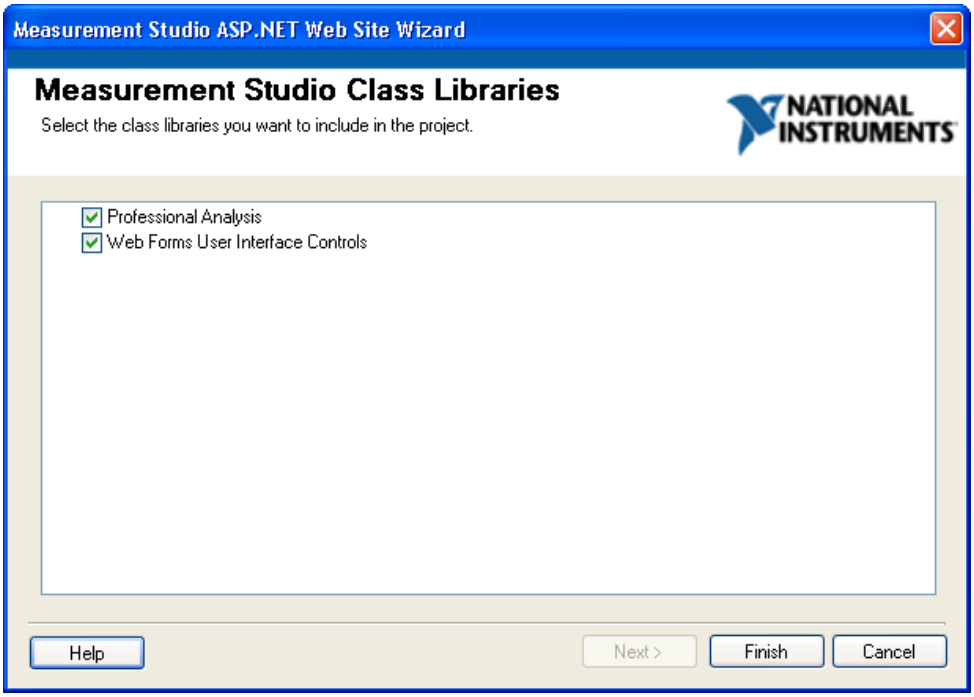
Setting up the project

1. Select **Start»All Programs»Microsoft Visual Studio 2005» Microsoft Visual Studio 2005**.
2. Select **File»New»Web Site**. The New Web Site dialog box launches.



3. In the Templates pane, select **Measurement Studio ASP.NET Web Site**. Select **File System** and specify a **Location** of your choice.
4. Use the drop-down box to select **Visual C#** or **Visual Basic**, depending on which language you want to create the project in.

5. Click **OK**. The Measurement Studio ASP.NET Web Site Wizard launches.
6. Select **Analysis** and **Web Forms User Interface Controls**.

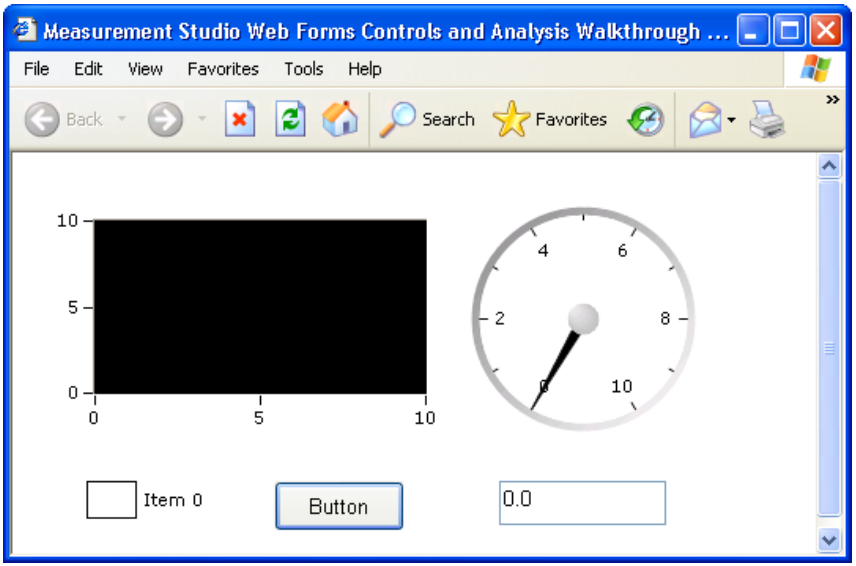


Tip If you are working with an existing project, you can access the Measurement Studio ASP.NET Web Site Wizard dialog box by selecting **Measurement Studio»View .NET Class Library Wizard**.

7. Click **Finish** to display `Default.aspx` in the Web Forms Designer.

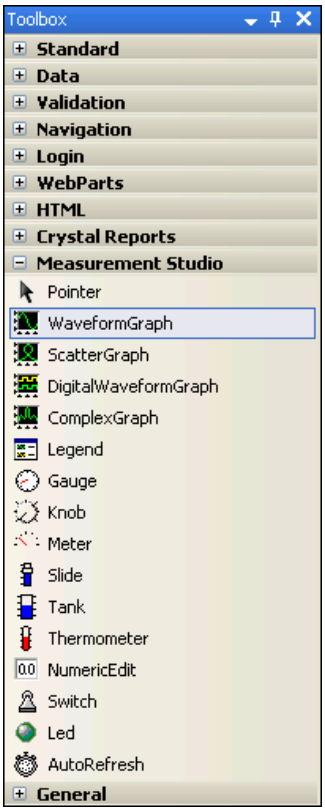
Adding user interface controls to the project

In this section, you will build a Web page that looks like the following screenshot.



1. Select **View»Toolbox** to display the Toolbox. The toolbox contains components and controls that you can add to your project.
2. Click **Design** to switch from Source View to Design View.
3. Select **View»Toolbox** to display the Toolbox. The toolbox contains components and controls that you can add to your project.
4. Expand the **HTML** group on the Toolbox. Select the Table control in the toolbox and drag and drop it onto the form. You use the table cells to arrange the user interface controls on your Web page, as shown in the previous screenshot.
5. Expand the **Standard** group on the Toolbox. The Standard group contains ASP.NET server controls included in the `System.Web.UI` namespace.
6. Select the **Button** control in the toolbox and drag and drop it into a table cell.
7. Right-click the button and select **Properties** to display the Properties window. You configure the properties of the control in the Properties window.

8. Scroll to the Text property in the Properties window. Type `Start` for the button text.
9. Select the **Measurement Studio** tab on the Toolbox.
10. Select the **WaveformGraph** control and drag and drop it into a table cell.

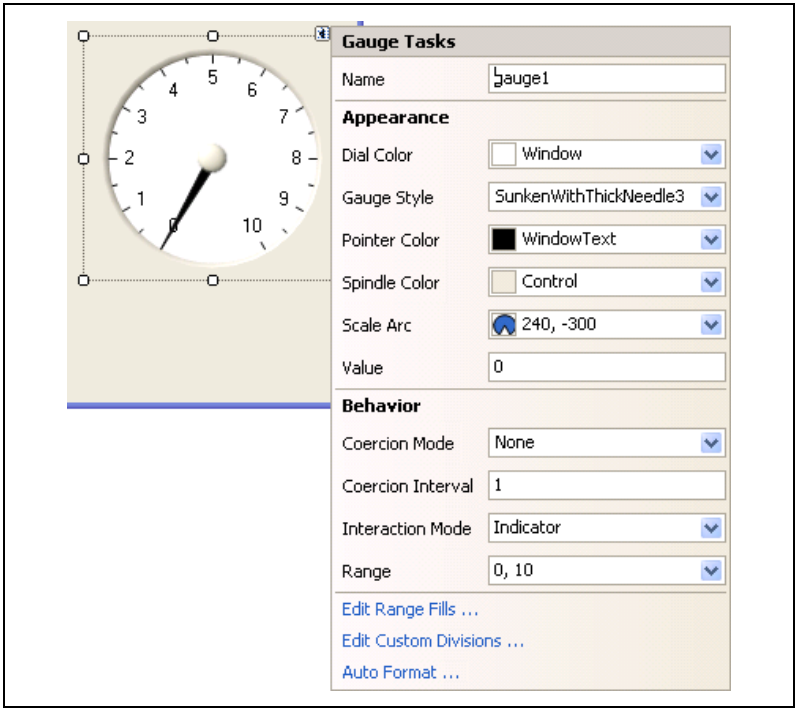


11. On the waveform graph smart tag, type `graph` for the name of the waveform graph ID.

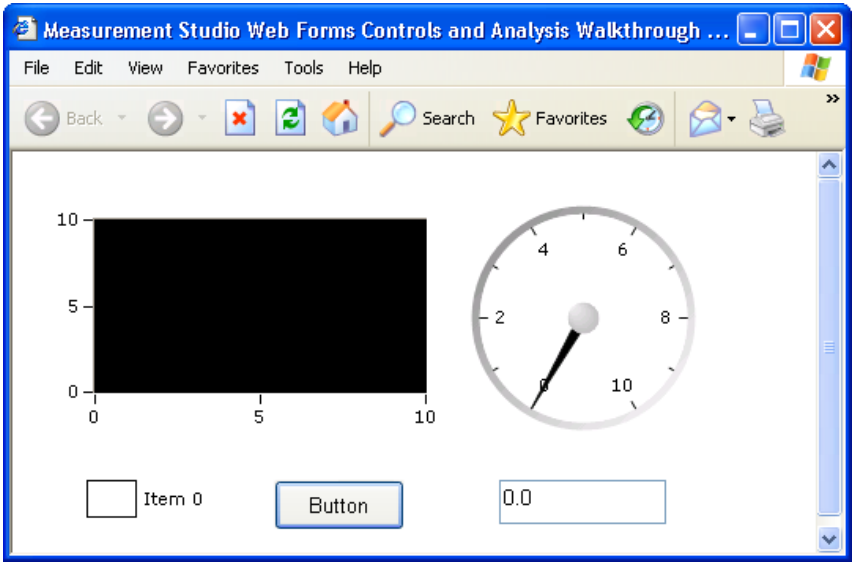
Tip You access the smart tag by right-clicking the arrow button in the upper right corner of the control.

12. Select the **Legend** control and drag and drop it into a table cell.
13. Select the **NumericEdit** control and drag and drop it into a table cell.

14. On the numeric edit smart tag, type `numericedit` for the **Name** of the numeric edit ID.
15. Select the **Gauge** control and drag and drop it into a table cell.
16. On the gauge smart tag, type `gauge` for the **Name** of the gauge ID. The following screenshot shows the Web page with the user controls.



Generating, plotting, and analyzing the data



1. Double-click the button control to display the `Default.aspx.cs` code, with the cursor inside the click event handler of the button control.
2. Add the following code to generate random data, plot the data, calculate the mean of the data, and display the mean on the gauge.

[VB.NET]

```
' Declare and initialize an instance of WhiteNoiseSignal.
Dim whiteNoise As New WhiteNoiseSignal()
' Store the generated data in a double array named data.
Dim data As Double() = whiteNoise.Generate(1000.0, 256)
' Use the PlotY method to plot the data.
Plot.PlotY(data)
' Use the Mean method to calculate the mean of the data.
Dim mean As Double = Statistics.Mean(data)
' Display the mean on the gauge.
gauge.Value = mean
```

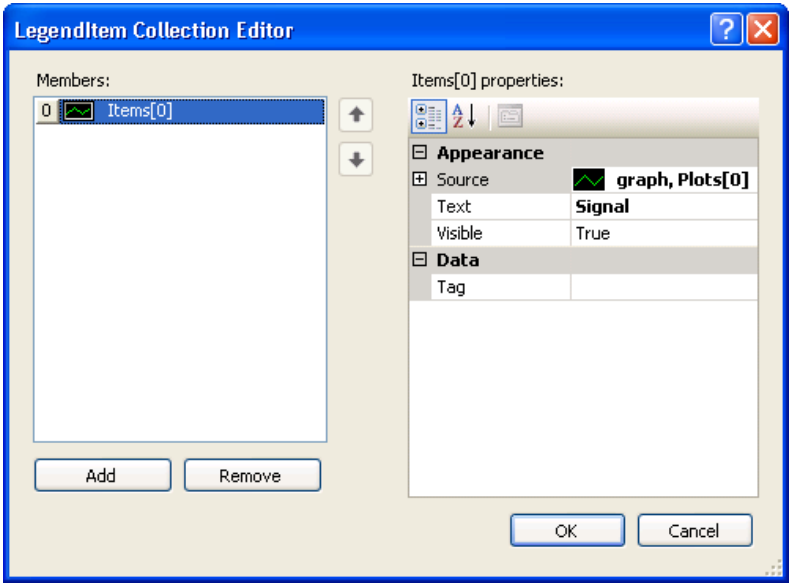
[C#]

```
// Declare and initialize an instance of WhiteNoiseSignal.
WhiteNoiseSignal whiteNoise = new WhiteNoiseSignal();

// Store the generated data in a double array named data.
double[] data = whiteNoise.Generate(1000.0, 256);


// Use the PlotY method to plot the data.
Plot.PlotY(data);

// Use the Mean method to calculate the mean of the data.
double mean = Statistics.Mean(data);

// Display the mean on the gauge.
gauge.Value = mean;
```

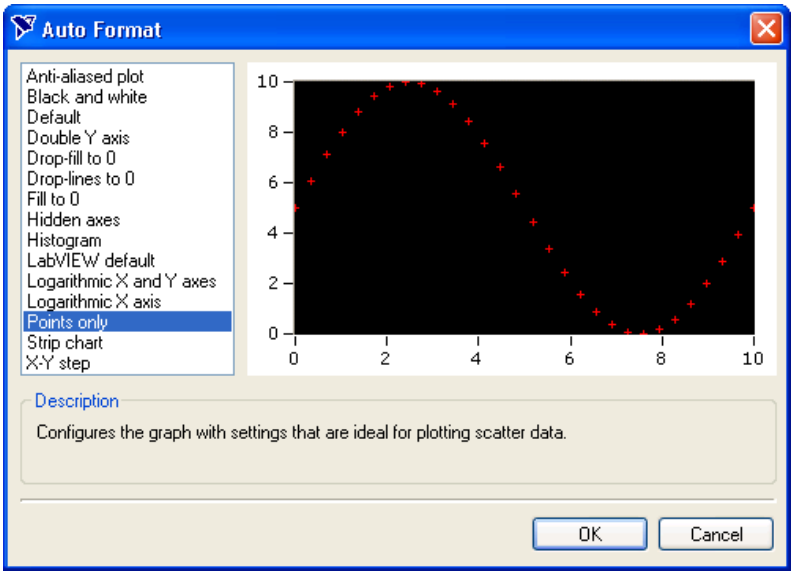
Customizing your user interface

1. Select the **Default.aspx** tab to return to the Web Forms Designer.
2. Right-click the legend and select **Edit Items** to display the LegendItem Collection Editor dialog box. You use the LegendItem Collection Editor to add or remove legend items and to configure legend item properties.

3. Select **graph, Plots[0]** in the **Source** drop-down list and enter `Signal` in the **Text** box. Click **OK**. Now that you have specified a legend item for the plot, changes you make to the plot are reflected on the legend.

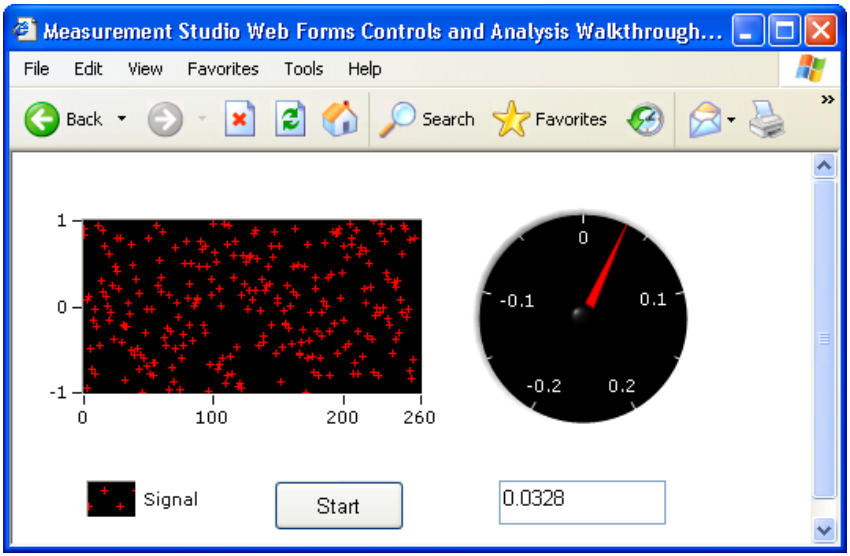


4. Right-click the graph and select **Auto Format** to display the Auto Format dialog box. The Auto Format dialog box provides a set of pre-configured control styles. When you select a style and click **OK**, the Auto Format feature configures the appropriate control properties to reflect the style you chose.
5. Select **Points Only**. Click **OK**. Notice that the legend changed automatically to match the formatting of the graph.
6. Right-click the gauge and select **Auto Format** to display the Auto Format dialog box.



7. Select **Dark** and click **OK**.
8. Right-click the gauge and select **Properties** to display the Properties window.
9. Set the Range property for the gauge with the drop-down Range type editor. Type `-0.2` for the minimum value and type `0.2` for the maximum value.
10. Right-click the numeric edit and select **Properties** to display the Properties window.
11. Select **Gauge** in the **Source** drop-down list. Setting the Source property to the gauge allows two-way binding between the controls.
12. Deselect **ArrowKeys**, **Buttons**, and **Text** for the **InteractionMode** property of the numeric edit control. Deselecting these interaction modes makes the numeric edit an indicator.
13. Select the Format Mode property and in the Numeric Edit Format Mode Editor dialog box, change the Precision to `4`.
14. Select **File»Save Form1.cs** to save your application.
15. Select **Debug»Start Without Debugging** to run the application.
16. After your program builds and runs, click **Start**. Notice the graph shows the data plot, and the gauge and the numeric edit display the mean of the data.

The following screenshot shows the Web page with customization.



A

Contacting Measurement Computing Corp.

You can reach Measurement Computing Corp. through the following ways:

Mail
Measurement Computing Corp.
16 Commerce Blvd.
Middleboro, MA 02346

Telephone
508-946-5100

FAX
508-946-9500

Technical Support
techsupport@MeasurementComputing.com

Sales
sales@measurementcomputing.com

Other correspondence
info@measurementcomputing.com

Visit our Web site at www.measurementcomputing.com.

Glossary

A

analog I/O	Reading or writing data in continuously variable physical quantities, such as voltage or current.
annotate	Adding text, arrows, or shapes to describe or highlight a point or region on a graph.
API	Application Programming Interface. A specification of software functions and their input and return parameters.
array control	An array of Measurement Studio user interface controls that behave as a single unit.
assembly	A collection of one or more files that are versioned and deployed as a unit. An assembly is the primary building block of a .NET Framework application. All managed types and resources are contained within an assembly and are marked either as accessible only within the assembly or as accessible from code in other assemblies.
asynchronous	Function that begins an operation and returns control to the program prior to the completion or termination of the operation.

B

button	A control used to input or display Boolean information or to initiate an action in a program.

C

chart	To append new data points to the end of an existing plot over time.
client callback	In Web Forms, page calls back to the server without fully posting back. Callbacks are asynchronous and are accomplished with XML-HTTP. Client callbacks do not include postback data, and they do not force the page to refresh. Client callbacks do require a browser that supports the XML-HTTP protocol.

coercion	Automatic conversion that Measurement Studio controls perform to change the numeric representation of a data element.
complex graph	A control that displays a `ComplexDouble` data type; the `ComplexDouble` data type represents a complex number of type `Double` that is composed of a real part and an imaginary part.
context-sensitive help	Help for dialog boxes, the controls in dialog boxes, and keywords in source code that you can access with the key or a Help button, or by clicking the link that appears in the Dynamic Help window in Visual Studio.
control	Object for entering, displaying, or manipulating data on a user interface.
counter/timer I/O	Reading or writing data based on high-precision timing through a counter or timer. By combining a counter with a highly accurate clock, you can create a wide variety of timing and counting applications, such as monitoring and analyzing digital waveforms and generating complex square waves.
cursor	Flashing rectangle that shows where you may enter text on the screen. If you have a mouse installed, there is a rectangular mouse cursor, or pointer.
cursor label	Text object used to display X and Y coordinates that a cursor crosshair points to on a graph.

D

DAQ	Data acquisition. Process of acquiring data, typically from A/D or digital input plug-in boards.
DAQ device	A device that acquires or generates data and can contain multiple channels and conversion devices. DAQ devices include plug-in devices which connect to a computer USB port or PCI bus.
device	An instrument or controller you can access as a single entity that controls or monitors real-world I/O points. A device is often connected to a host computer through some type of communication network.
digital I/O	Reading or writing digital representations of data in discrete units (the binary digits 1 and 0). Digital information is either on or off.
digital waveform graph	A control that displays `DigitalWaveform` data on a Windows Forms or Web Forms user interface; the `DigitalWaveform` data type represents a set of digital states that are grouped by samples or signals.

distribution	Ability to install programs you develop with Measurement Studio to others working on different computers.
DLL	Dynamic Link Library. A library of functions that link to a program and load at run time rather than being compiled into the program. Loading libraries only when they are needed saves memory in software applications.
DMM	Digital Multimeter. A common measurement instrument that measures resistance, current, and voltage in a wide variety of applications.
downlevel browser	Previous generation Web browser with limited client interaction. *See also* uplevel browser.
driver	Software that controls a specific hardware device, such as a data acquisition board or GPIB interface board. *See also* instrument driver.

E

Ethernet	Standard connection type for networks, where computers are connected by coaxial or twisted-pair cable.
event	Object-generated response to some action or change in state, such as a mouse click or a completed acquisition. The event calls an event procedure that processes the event.
executable	Program file with a `.exe` extension that you can run independently of the development environment in which it was created.

F

form	Window or area on the screen on which you place controls and indicators to create the user interface for your program.
front panel	Interactive user interface of a virtual instrument. Modeled after the front panel of physical instruments, it is composed of switches, slides, meters, graphs, charts, gauges, LEDs, and other controls and indicators.
FTP	File Transfer Protocol. Protocol based on TCP/IP to exchange files between computers.

G

gauge	A control used to input or display numerical data.
GPIB	General Purpose Interface Bus. The standard bus used for controlling electronic instruments with a computer. Also called IEEE 488 bus because it is defined by ANSI/IEEE Standards 488-1978, 488.1-1987, and 488.2-1987.
graph	A 2D or 3D display of one or more plots.

H

HTTP	HyperText Transfer Protocol. Protocol based on TCP/IP, which is used to download Web pages from an HTTP server to a Web browser.

I

IEEE 488	Shortened notation for ANSI/IEEE Standards 488-1978, 488.1-1987, and 488.2-1987. *See also* GPIB.
indicator	A control in read-only mode.
installer	Software program that copies program, system, and other necessary files to computers.
instrument driver	Library of functions to control and use one specific physical instrument. Also a set of functions that adds specific functionality to an application.
interface	Connection between one or more of the following: hardware, software, and the user. For example, hardware interfaces connect two other pieces of hardware.

K

knob	A control used to input or display numerical data.

L

LED	Light-Emitting Diode. An indicator that emits a light when current passes through it. For example, an LED shows if your computer or printer is turned on.
legend	A control that displays symbols and descriptions for a specific set of elements of another object, such as the plots or cursors of a graph.

M

matrix	A rectangular array of numbers or mathematical elements that represent the coefficients in a system of linear equations.
MB	Megabytes of memory.
MCC-488.2	Driver-level software to control and communicate with Measurement Computing GPIB hardware.
Measurement Studio	National Instruments software that includes tools to build measurement applications in Visual Basic .NET and Visual C#.
meter	A control used to input or display numerical data.
method	Function that performs a specific action on or with an object. The operation of the method often depends on the values of the object properties.

N

numeric edit	A control used to display and edit numeric values.

O

oscilloscope	Measurement instrument widely used in high-speed testing applications, such as telecommunication physical layer testing, video testing, and high-speed digital design verification.

P

PCI	Peripheral Component Interconnect. High-performance expansion bus architecture commonly found in PCs.
plot	1. Trace (data line) on a graph representing the data in one row or column of an array. 2. To display a new set of data while deleting any previous data on the graph.
point	Structure that contains two 16-bit integers that represent horizontal and vertical coordinates.
postback	The process in which a Web page sends data back to the same page on the server.
property	Attribute that defines the appearance or state of an object. The property can be a specific value or another object with its own properties and methods. For example, a value property is the color (property) of a plot (object), while an object property is a specific Y axis (property) on a graph (object). The Y axis itself is another object with properties, such as minimum and maximum values.
property editor	A control used to configure properties for Windows Forms controls at run time.
property pages	Window or dialog box that displays current configuration information and allows users to modify the configuration.

R

range	Region between the limits within which a quantity is measured, received, or transmitted. The range is expressed by stating the lower and upper range values.

S

scalar	Number that a point on a scale can represent. The number is a single value as opposed to an array.
scale	Part of graph, chart, and some numeric controls and indicators that contains a series of marks or points at known intervals to denote units of measure.

scatter graph	A control that displays two-dimensional data on a Windows Forms or Web Forms user interface; displays a graph of X and Y data pairs.
scope	*See* oscilloscope.
serial	Standard serial bus on a computer used to communicate with instruments. Also known as RS-232.
slide	A control used to input or display numerical data.
slider	Moveable part of a slide control.
smart tag	A glyph attached to a Measurement Studio control or component that exposes commonly performed tasks.
switch	A control used to receive and control Boolean input in an application user interface.
synchronous	Property or operation that begins and returns control to the program only when the operation is complete.

T

tank	A control used to input or display numerical data.
TCP/IP	Transmission Control Protocol/Internet Protocol. A standard format for transferring data in packets from one computer to another. The two parts of TCP/IP are TCP, which deals with the construction of data pockets, and IP, which routes them from computer to computer.
thermometer	A control used to input or display numerical data.

U

UI	User Interface.
uplevel browser	Recent generation Web browser that supports rich client interaction and functionality. *See also* downlevel browser.

V

vector	1D array.
VXI	VME eXtension for Instrumentation. Instrumentation architecture and bus based on the VME standard. Used in high-end test applications.

W

waveform graph	A control that displays two-dimensional data on a Windows Forms or Web Forms user interface; displays data that is uniformly spaced in one dimension.

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